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THE NEW HOTEL DE VILLE OF THE CITY OF PARIS.

THE corner stone of the old Hotel de Ville of Paris was laid on the 15th of July, 1533, three hundred and fifty years ago.

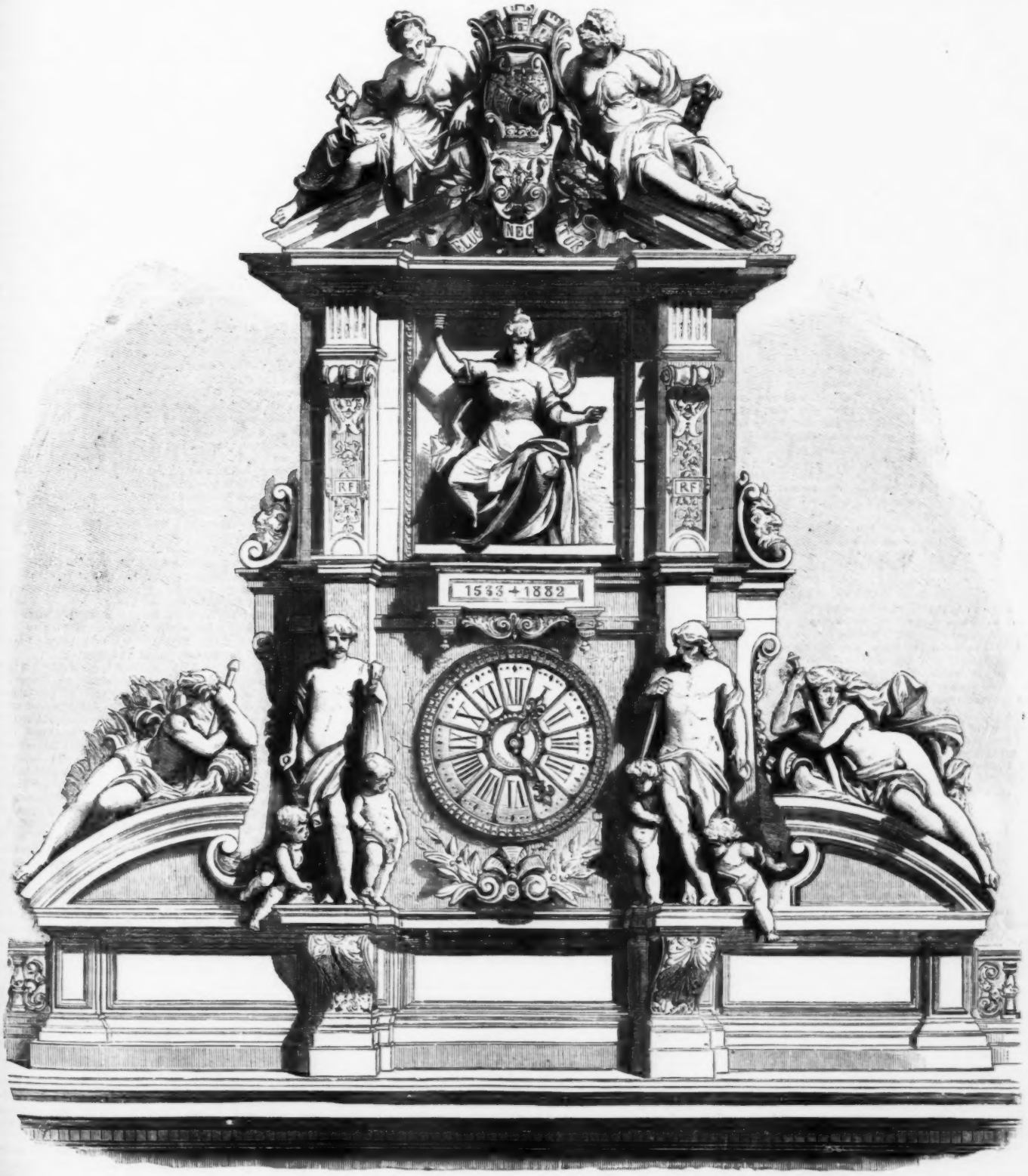
It was once said (and the error has been perpetuated up to the present time) that this marvel of art was planned by a foreigner, but the truth is that it was the work of a Frenchman—Pierre Chambiges.

This noted structure, situated between Rue de Rivoli and the river, opposite the upper end of Ile de la Cité, was, before its almost total destruction by the Commune in 1871, a most beautiful building, in the style of the renaissance, forming a quadrangle about 300 by 250 feet, and having three courts. Its exterior was profusely ornamented, several hundred statues in niches forming part of its decorations; while the state apartments within were among the most magnificent rooms in the world, the great *galerie des fêtes* being especially splendid. The structure is connected with nearly every important event in the modern history of Paris. As before stated, it was begun in 1533, and the first building, about one-fourth the size of the subsequent one, was finished in 1628. It remained almost untouched till 1837, when improvements were begun, and in 1842 it was enlarged to its greatest dimensions.

Immediately after the defeat of the Commune, the Municipal Council, at one of its first sessions, unanimously decided to set aside thirty million francs for reconstructing the burned edifice on a grander scale than before.

The matter was accordingly put into the hands of the Council of Architecture to report upon. This body, in conjunction with the Commissions of Fine Arts and Historic Works, after spending much time in a study of the subject, recommended that the edifice should be reconstructed so as to unite the apartments of the prefect, the municipal council, and the administrative services; that the work of Messrs. Godde & Lesueur on the façade that escaped the fire on Place Lobau should be preserved; that the primitive edifice called the Boccador should be exactly reproduced in all its details, as should be also the court of Louis XIV., the staircase of Marin de la Vallée, the hall of the throne, the projecting turrets and the Campanile.

The report was accepted, and, in 1873, the government chose, out of the seventy competing plans, those of Messrs. Ballu & Deperthes, and intrusted the work of reconstruction to these architects. The original specifications contemplated the utilization of as much of the remaining part of



THE GREAT CLOCK OF THE NEW HOTEL DE VILLE, PARIS.

the structure as possible; but, on a careful examination, it was found that very little of the old municipal palace could be preserved, and the present building is, therefore, substantially new throughout.

The new edifice has been given greater size by advancing its façades on Place de l'Hotel de Ville, on Rue de Rivoli, and on the Quay, and by extending the principal façade by twenty-two meters. The facade of the Hotel de Ville of the sixteenth century has been exactly reproduced, but the work of Lesueur & Godde has undergone important modifications in details and arrangement. The old facade in Rue de Rivoli has undergone an almost radical transformation in the erection of a kind of external hall, designed for financial services. The decoration of the attic of the *Salle des Fêtes* on Place Lobau is very different from the old, there having been substituted for it a series of eight very richly ornamented pediments surmounting arched windows, and accompanied by coffers on which are sculptured the arms of the principal cities of France.

The internal arrangement of the buildings has been considerably modified, the three courts, which in the former structure were irregular in shape, being in this nearly square.

Great attention has been bestowed on the sculptural decoration of the new Hotel de Ville. The character of the French renaissance style is well adapted to the use of statues, bass-reliefs, and richly carved arched and dormer windows. All those statues of illustrious persons that have honored the city compose a superb guard of honor at the Municipal Palace. The Campanile, with its large and beautiful allegorical figures, forms the center of the decoration. Above, two female figures, sculptured by Mr. Gautier, and seen holding the arms of the City of Paris, crown the pediment. Underneath this is seen seated a statue emblematic of the City of Paris, the work of Mr. Gautberin. Upon the two pilasters on each side of the clock are sculptured two groups of men and children—*Work and Study*. These are from the chisel of Mr. Hiolle. The two reclining figures, external to the last mentioned, are emblematic of the *Seine* and *Marne*, and are the work of Mr. Millet.

Thirty statues emblematic of cities surmount the upper cornice of the buildings between the corner pavilions and the restored facade of the sixteenth century, and one hundred and ten statues of illustrious men, Parisians by birth, ornament the various stories of the different facades. The ridge-piece of a part of the ancient facade is crowned with six gilded statues of chevaliers, symbolical of the bourgeois nobility of Paris—*civitas equestris*, as it is formally called in the letters patent of Charles V., dated from the Hotel Saint Paul, August 9, 1371.

The present Hotel de Ville has cost about twenty millions and a half. The enlargement of the old Hotel, executed by the architects Godde & Lesueur, cost sixteen millions. The decorative work yet to be executed will doubtless carry the expense of reconstruction up to about twenty-two millions. We are indebted to *L'Illustration* for the accompanying cuts.

[Continued from SUPPLEMENT 346, page 5515.]

THE PANAMA CANAL.

By MANUEL EISSLER, M.E., of San Francisco, Cal.

IV.

IN December, 1849, Mr. J. C. Trautwine arrived at the Isthmus of Panama, for the purpose of locating the Panama Railroad, and commencing its construction. Col. George W. Hughes, at the head of a party of engineers, had made an exploration of the country the previous year, and had reported in favor of commencing the railroad at Gorgona, and building from that place to Panama, using the Chagres River as a means of transportation to that point, which he reported as suitable for that purpose.

This was considered the quickest and most economical way of effecting the transit, leaving that portion of the railroad line between the Atlantic (Caribbean Sea) and Gorgona to be constructed afterward.

Mr. Trautwine went to the isthmus to carry out this plan. The company had sent out a small steamboat called the General Herran for the purpose of carrying passengers and freight on the Chagres River, and thus inaugurating this part of the programme.

I arrived at the isthmus in February, 1850. It was then the dry season and the river was at a low stage. I spent two nights and one day in the passage up the river to Gorgona in a small canoe, grounding at various places. The steamboat General Herran was lying high and dry on the river bank, half way up, ten or twelve feet above the then level of the water, where she had been carried by a freshet. Boats loaded with lumber and other materials on their way up the river were aground and unable to proceed.

Mr. Trautwine had established himself and party at Gorgona, and had commenced the survey of the line of the railroad toward Panama, but transportation by the river at this season of the year had been found utterly impracticable for any such purpose as that of supplying material for the construction of a railroad, or even for the transportation of passengers with comfort and decency.

It was evident that the railroad must be commenced at the Atlantic—that it was more important to supplant the river than the land portion of the route. Investigations were accordingly turned in that direction, and the present terminus, on the Island of Manzanilla, in Navy Bay—also called Bay of Limon—was determined upon.

I remained on the isthmus only a few weeks on this my first visit, having engagements in the adjoining province of Cartagena.

The approval of the company having been obtained to the proposed change of plan, Mr. Trautwine moved his headquarters to Navy Bay.

A vessel had been sent there from New York with provisions, tools, lumber, and a ready-made storehouse. I sent laborers from Cartagena. The Island of Manzanilla, now occupied by the town of Aspinwall, was then covered by a dense forest; all except the north and a portion of the west edge of it was swampy; and the only living things upon it were frogs, sand flies, and mosquitoes. No animals were there, not even snakes, and the birds seemed to avoid it. It was impossible to live on it. The negro laborers working there were obliged to veil their faces from the sand flies and mosquitoes at mid day.

The first thing to be done was to clear this island, which was commenced at once. Mr. Trautwine and his party, in the meantime, lived on board the brig which had brought the materials, which he detained for this purpose and until a storehouse could be erected for storing her cargo.

In June I visited the isthmus again, having accompanied Mr. John L. Stephens (then Vice President, afterward President of the company) from Cartagena, on his return from Bogota, where he had been for the past six months, during the session of the congress of New Granada (now Colombia), for the purpose of procuring amendments to the contract for building the railroad. At this time a storehouse had been erected on the island, and a large space of clearing had been made; but only the negroes could live on shore.

The steamboat Telegraph, which had taken a load of passengers to Chagres, having been condemned and sold, we purchased the hulk, and took it to Navy Bay as a residence. Mr. Stephens took passage on the first steamer for New York. Mr. Trautwine followed him a few weeks later.

I remained in charge of the work, with headquarters on the hulk in the bay, while I made explorations for the line of railroad from this point towards the Chagres River, which Colonel Hughes had left unexplored on account of the swamps, which he reported impassable. It was in the depth of the rainy season, from which we suffered ill health and discomfort, with very unsatisfactory progress in our survey.

After Mr. Trautwine's return from New York, in September, I again went to Cartagena, to conclude my business there and to procure more laborers for the work, the grading of which we intended to commence the approaching dry season. In the meantime, as the clearing of the island progressed, ready-made houses were ordered, and carpenters to erect them.

During my absence on this occasion, Mr. Trautwine resigned his position with the company (we were associate engineers), and I returned in full charge of the work, as chief engineer.

It was now near the end of November, 1850. Nearly a year had been spent in preliminary arrangements. We had not done as much toward preparing for work as the canal company has done the past year. We could not effectively do more. Surveys were next to impossible during the rainy season. We had a virgin wilderness to encounter, which it was useless to attempt along the line of California travel with the men we could bring from Cartagena, which were the only laborers then available. It was difficult to retain them on the island, outside of that line of travel, so great were the attractions to it. But we had made a good beginning, and earnest work was at hand.

Quite a village had grown up on the Island of Manzanilla, during my absence in September and October. Forty five carpenters were on hand, but only three or four of them were at work, or able to work. They were laid up with fever and ague. They had put up six or seven houses which had been sent from New York, and were comfortably quartered, as were also the officers of the company, including two or three physicians who had been sent to us. Besides the carpenters, there were between one hundred and two hundred negro laborers on the island; and at Monkey Hill, on the line of road, about two miles from the island station, there were forty Irishmen, who had been brought from New Orleans.

A large number of laborers, foremen, etc., had been engaged by the company in New York, and were expected to arrive here in the next month or six weeks, without an inch of line being located for them to work on or a house built to shelter them. The location which has been made from the island toward the river was entirely through swampy ground, excepting about a quarter of a mile in length at Monkey Hill where the Irishmen were stationed. It was intended to make a pile road through these swamps, and the pile drivers and men to work them were expected by the first steamer.

The materials for ready-made houses for the line of road had arrived, and some of them had been sent to Gatun. No time was lost in routing out four or five carpenters, taking them to Gatun station, seven miles up the river, the day after my arrival, and setting them to work putting up a house. Materials for other houses were sent to Buhio Soldado, 15½ miles, and to Frijole, 19 miles, and carpenters were sent to erect them as fast as they got well enough to work.

On the 15th December about four hundred men arrived from New York, including a number of carpenters, who were sent to Gatun. They arrived there on Sunday morning. The house frame was up and sided. The newly arrived carpenters immediately went to work on it, and by night the roof was on, and the whole party were comfortably sheltered.

About the 5th of January, 1851, a party of about three hundred more men arrived. These were sent to Buhio Soldado, where, in the same way as at Gatun, they were sheltered the first night of their arrival.

The next party arrived at about the 15th of January. They were chiefly from Illinois, and were sent by Colonel E. D. Baker, under a contract with the company. They were to work a hundred days, for which they were to receive $25 cash, and a passage to California. These were first sent to Monkey Hill, and afterwards to Frijole station. Only about ninety out of the three hundred completed their contract. The rest went back to their homes through illness or other causes before they had completed their hundred days, except the few who died.

Altogether about nine hundred men arrived and were put to work in December, 1850, and January, 1851. Assistant engineers came with the men, and were immediately employed in locating the line, and preparing work for excavation.

The sites selected for these stations were controlling points of the line of the road, governed by the river Chagres and the spurs of hills, with low ground intervening; so that the line could be conveniently located in this detached way, from point to point, which was very fortunate. Beyond Frijole the line was not so well defined, and a party of engineers was put upon the survey, between this and Panama, as soon as it could be organized.

The isthmus portion of the general line of travel to and from California was disagreeable and expensive; and the progress of the railroad was anxiously watched. Its success was considered as problematical as the construction of the canal is at the present time, and just as many reports were made against the probability, or even possibility, of its ever being completed—of the slow progress of the work, and of the sickness and deaths among the workmen, which were greatly exaggerated.

As the line lay through a virgin tropical forest, after it was felled and cleared, and the surface of the ground, covered with the accumulated vegetable mould and *debris* of ages, was exposed to a tropical sun, of course a miasmatic atmosphere was created, to which the whole of our workmen were exposed, and from which many suffered. A large portion of them were constantly in hospital, but their complaint was generally only light fever and ague, with some cases of dysentery.

Under our rule of clearing the hospitals of, and sending home by every steamer, every man whom the physicians thought would not be able to do good service within a reasonable time, very few deaths took place among them, many men's lives were saved and their health restored.

With these drawbacks progress was slow, of course; but the majority of travelers who passed up and down the river knew very little of what was being done, and generally took a gloomy view of the condition of things, and so reported them on their arrival at their destination, and especially at the office of the company.

Although I had a severe attack of inflammation of the bowels early in the season, from which I had frequent relapses afterwards, I remained at my post of duty until I saw that the railroad was within two weeks of being in running order from Aspinwall to Gatun station; when, suffering from one of those relapses, and a steamer being on the eve of starting, the surgeon attending me insisted upon my leaving that climate and going North. This was September or October, 1851. Work had been prosecuted up and down the line each way from every station as they were first established, and from an intermediate station at Ahorca Lagarta, thirteen miles from Aspinwall, so that the first twenty miles of the road was pretty nearly graded, only requiring to be joined together by short distances. But our forces were reduced; the first $1,000,000 of capital, which was all that had been subscribed, was nearly exhausted; and the company were undecided in their plans for the future.

Arriving in New York I found a gloomy state of feeling prevailing among the directors. A prominent member of the board called upon me and stated how much dissatisfaction as well as discouragement existed among them. I saw immediately that, instead of attending to my statements contained in my bimonthly letters to them, they had given more credence to the unreliable reports of travelers. I explained the actual condition of the works to him—that by that time the cars were probably running to Gatun station, how much of other parts of the line was graded, and that if a sufficient number of laborers could be obtained the road could be completed to the crossing of the Chagres River, twenty-three miles, by the next July (1852).

I also told him that we could commence carrying passengers as far as Gatun at once, and increase the distance we carried them from time to time until we arrived at the river, with profit to the company and comfort to the passengers.

My friend was delighted and surprised at what I told him, and requested me to meet the board of directors of the company, whom he would call together the next day.

My statements to the board of directors consisted of the same simple facts, which was no more than a repetition of the substance of my letters, but was really like a revelation to them, reviving their spirits and renewing their hopes. They were men of energy and means, but they had been discouraged by misinformation.

Capital for prosecuting the work was readily found, more men were ordered, and I was able to perform my promise of completing the road to the river crossing at Barbacoas by the following July.

The company having acceded to my plans for continuing the construction of the railroad, I returned to the isthmus, after a stay of three or four weeks with my family, Mr. John L. Stephens, then president of the company, having preceded me.

On my arrival I found that the work had progressed according to my expectations. The road was in running order to Gatun station, and a gravel train was at work upon it, filling in the piling and cribbing upon which the greater part of the track was laid.

December 8, the steamer Georgia, under the command of Captain (now Admiral) Porter, came into Navy Bay with a large load of passengers, being unable to land them at Chagres on account of a heavy sea rolling in there. The object of Capt. Porter in bringing his ship into this port was, first, to get a quiet place of anchorage until the sea abated, but chiefly to get the passengers carried through to Gatun station by railroad, if possible.

We had not intended to open the road for travel quite so soon. We had a number of passenger cars on hand, but they had not been run and were not in order for such immediate use. We offered to fit up our gravel cars for the conveyance of the passengers, which was gladly accepted; and thus, seated on rough boards or on their trunks, in the gravel cars, twelve hundred as jolly passengers as ever traveled, inaugurated the opening of the first seven miles of the Panama Railroad.

From this time forward the passengers preferred this route; the steamship officers, of course, preferring the quiet anchorage of Navy Bay to the heavy swells of the open roadstead at the mouth of the Chagres.

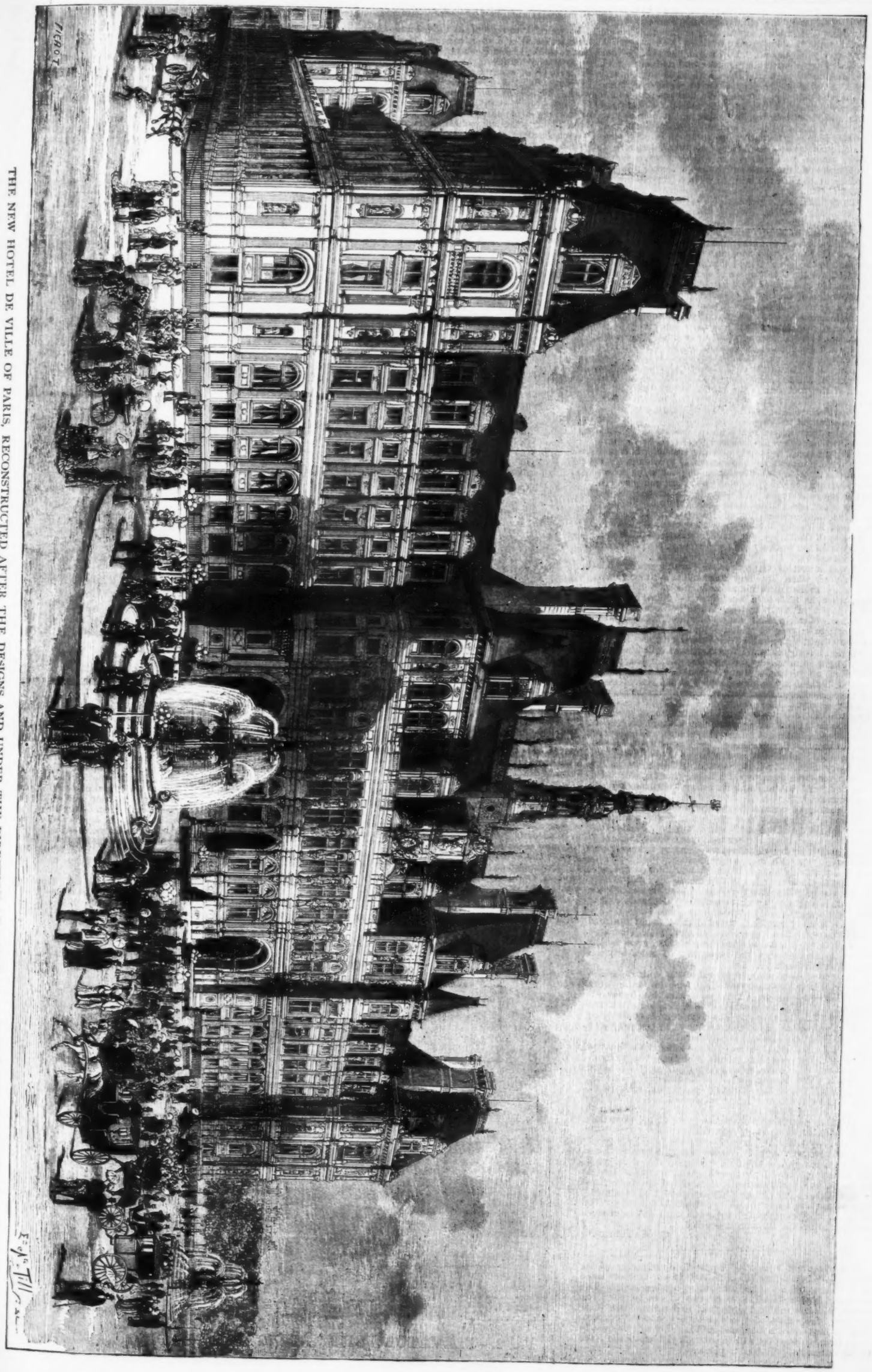
Up to this period only the employes of the company had been permitted to reside on the Island of Manzanilla; but now that the railroad was to form part of the transit route, and the island was to become the Atlantic terminus, some preparations must be made for accommodating the passengers. Accordingly, town lots on the island were sold, and the hotel keepers and merchants of Chagres and other places commenced building on them. The company had commenced the erection of an office, and taking advantage of the presence of Mr. Victoriano de Diego de Paredes and Mr. George Law, the corner stone of the office was laid with considerable ceremony by the former, February 22, 1852, inaugurating, or, as the New Granadians style it, "baptizing" the town with the name of *Aspinwall*, Mr. Paredes, Mr. Law, and Mr. Stephens making short speeches on the occasion. Mr. Parédes, as Secretary of Foreign Relations of New Granada, had made the contract with Mr. Stephens the year previous for the construction of the railroad, and was now on his way as minister from his government to Washington. This is the origin of the name of Aspinwall for this place, and although the legislature of the province afterward named it Colon, the true name of it is Aspinwall, according to their own custom of naming places. In this country, just as elsewhere, the founders of a town have a right to name it.

By April the road was open to Ahorca Lagarta, 13 miles, then later to Frijole, 19½ miles, and so on until July, when the trains ran to Barbacoas, 23 miles, nearly half way to Panama, saving the passengers one and a half to two days of river travel. Here the railroad was to cross the Chagres River by a bridge, 600 feet in length, which would make this a stopping place for some months.

In the meantime considerable speculation had taken place in the stock of the company. It rose to 140 for a few days; but fell back to 80. Confidence in the enterprise had increased, however, and means for its promotion were more readily obtained.

The cost of the road thus far had much exceeded all expectations. The whole work had been under my control. My principal assistant engineer, Mr. James L. Baldwin, and three young men who had been with me some years on the

THE NEW HOTEL DE VILLE OF PARIS, RECONSTRUCTED AFTER THE DESIGNS AND UNDER THE DIRECTION OF BALLU AND DEPERTHES, ARCHITECTS.



THE NEW HOTEL DE VILLE OF PARIS, RECONSTRUCTED AFTER THE DESIGNS AND UNDER THE DIRECTION OF BALLU AND DEPERTHES, ARCHITECTS.

construction of the canal of the Digue, in Cartagena, as superintendents, were my chief dependence in carrying it on. Mr. John C. Campbell was locating engineer. We were eighteen months in constructing 23 miles, with which the company was well pleased, but thought that some of our large and well experienced contractors could do better, work quicker, and more economically. I thought so too, and cheerfully acceded to the proposition to get the remaining half of the road done by contract. We had passed through the swampy portion of the line; the rest of it ran through a higher and drier country, excepting about a mile near Panama which might be called swampy. Also, this part of the line was definitely located; maps and profiles of it were made; the quantity and character of the work determined; and there seemed to be no reason why contractors should not be found to do the work on reasonable terms. Besides the grading of the line the bridge over the Chagres was to be built.

Mr. George Law was a member of the board of directors of the company, which, legally, was an obstacle to his taking a contract under it; but he was an experienced contractor, possessed of large wealth, and therefore his connection with the contract was desirable. Associating him with Mr. Miner C. Story, who was also an experienced contractor, and in the name of the latter, a contract was made, May 8, 1852, for the construction of the 25 miles of the railroad from the crossing of the Chagres to Panama, and for the construction of the bridge over the Chagres. Of course, this was a great relief to me. I at once went to work to revise the location of this part of the line, which I wished to improve, if possible, and did improve considerably.

The contractors commenced work on the grading between the bridge and Gorgona in the summer of 1852, but did not prosecute it regularly until the dry season of 1853.

The piers and abutments of the bridge were built during the months of January, February, and March, 1853. The erection of the first span of the superstructure, 200 feet in length, was commenced about April 1, but unfortunately, about the 15th of this month, when the frame was nearly completed, but yet resting on its false works, a freshet took place in the river and carried it away. A freshet in April is an almost unprecedented occurrence in this river—this month being usually included in the dry season. This accident quite discouraged the contractors as to attempting to continue the erection of the bridge during the rainy season then evidently at hand. I insisted upon their going on with it, but seeing their hesitation I wrote to the company that if the contractors had any doubt of their ability to put it up during the rainy season, I would have it done for them if they would intrust it to me. My offer was accepted, and the erection of the bridge was prosecuted successfully without delay with the workmen of the company, at the expense of the contractors.

This was a sort of victory for me, for this reason: The previous year, when Mr. Law was on the isthmus, I was called upon to listen to his remarks about building this bridge, when he said, in a bragging way, that he would come and put in the pier foundations between steamers, that is, in two weeks, and made other assertions of similar import; in answer to which I told him that he could not put up the bridge at all at that season of the year, the rainy period having set in. I was afterward called upon to give this opinion in writing, on which occasion I said that I would put up the bridge at any season of the year. As it happened, both of my opinions, which at the time I made them were considered rash, were verified by the facts, and hence my victory.

No particular mishap occurred in the work of grading; but although the company gave the contractors every possible assistance, it did not progress favorably; as at the end of twelve months the grading of the first seven miles was only about half done.

Mr. Story died early in the season, at his home on the Hudson river, from dysentery, I believe, which he attributed to his first visit to the isthmus before the contract work was commenced.

The directors were much discouraged by the slow progress of the work. They saw that the contract was a mistake; that we should have kept the work in our own hands; that better progress was made under my management than under that of the contractors. The fact was, that my foremen, who had been so long with me—bright, active, young fellows—knew better how to manage in this climate than persons new to the country, however much experience they might have had elsewhere. They know especially how to manage the Cartagena laborers, upon whom we chiefly depended at that time.

When asked my opinion I stated that I thought the road could be completed to Panama by January, 1855. That was, to complete the 7 miles that had been worked upon by the contractors, and restruct the remaining 18 miles between Gorgona and Panama.

Steps were at once taken to get rid of the contract, which operation cost the company $100,000, and the whole work again fell into my hands, which I completed by the 29th of January, 1855. The last monthly estimate made for the contractors was in July, 1853. The compromise contract by which they gave up their contract, and the company paid their $100,000, was made in September, 1853.

It would have been done some days sooner if the weather had been more propitious. This year there was really no dry season. The continuous heavy rains greatly retarded the work. The last rail was laid at midnight, Saturday, January 27, 1855, in the midst of heavy rain, on a trestle work, 50 feet in height. I was compelled to send the first locomotive into Panama on Sunday, to try this portion of the road, on which there were stretches of high trestling, preparatory to taking heavy trains of passengers over it the next day.

As the road was virtually commenced on a Sunday, I was anxious to have it completed on some other day of the week, still retaining some of my New England notions of respect for the Sabbath. But the truth of the old adage was verified in this instance, that "man proposes and God disposes." May we not also apply this other old saw to this case, "The better day the better deed;" for what work has been more successful than the Panama Railroad?

G. M. TOTTEN.

POWER OF THE WAVES.—The tremendous power of sea waves was exhibited at Wick, on the extreme northern coast of Scotland, where a breakwater, was being built. The outer end was built of three courses of one hundred ton stones, laid on a rubble foundation; and above them three courses of large flat stones, and on these a mass of concrete built on the spot of cement and rubble. Though thought to be as immovable as the natural rock, it yielded to the force of the waves and crumbled to pieces.

THE SUEZ CANAL.

IF we refer to a profile of the isthmus, along the track of the Suez Canal, and to a concise classification of the soils that compose it (sands, clays, or muds, but no rock, even of secondary hardness), we shall readily obtain an idea of the methods of excavation that had to be adopted in order to bring about a successful termination of that colossal work. The digging of the maritime canal from Port Said to Suez, over its extent of ninety-six miles, was, in fact, only a long *dredging* operation in the sandy plains of the desert. The practical realization, however, much surpasses the simple conception that we give. What a gigantic work, in fact, must that have been which employed at one time eighty large dredges, twenty of them supporting chutes whose length exceeded, by one half, the height of the Vendome Column, and which together discharged on the banks of the canal in a single month sufficient material to cover, as high as the tops of the trees, the whole roadway of the Champs Elysées between the Obelisk and the Arch of Triumph! This amount of two million cubic meters that was removed by the Suez dredges, has given rise to estimates no less curious than the foregoing. This mountain of dredged matter, spread out from the Madeleine to the Bastille, would fill the Boulevard up to the first stories of the houses. Poured into the Place Vendome, it would be necessary to raise, one on top of the other, five circumferences of houses like those now standing there, in order to contain it. As for the total cubage of 73,000,000 meters of the entire canal there might be constructed with it a gigantic pyramid like that of the Pharaohs, but one having sides one kilometer in length at the base, and being 250 meters in height.

In addition to the accessory engines that we shall briefly enumerate further on, the extensive *materiel* for ditching this canal included, in the first place, dredging machines which, although proportioned to the grandeur of the work to be accomplished, resembled those ordinary dredges that we may see almost any day at work in our rivers and harbors. The interest that attaches to a description of the apparatus used on the isthmus resides, as we shall see, in the mode of emptying on the shore, either by means of long *chutes* or by *elevators*, or by cars annexed to the *dry excavator*, the dredgings that had been brought up by the buckets. When the dredgings were not thrown upon the shore to form the banks of the canal, or when the work was taking place in the proximity of the sea or of the interior lakes, they were emptied into false-bottomed punts that were towed out into the sea or lake and dumped therein. The dredge with long chute, that we show herewith in Fig. 1, consists essentially of an ordinary dredging machine whose chute has been elongated until it forms a semi-elliptical conduit 70 meters in length, 1·5 meters in breadth and 0·6 meter in depth, and which is supported by an iron framework that is itself supported by a barge. The entire affair is stiffened by iron cross braces, which connect the dredging machine with the barge. A sweeping chain, in a jet of water kept in operation by a pump, hastens the descent of the sand in the chute, which has an inclination of 0·04 to 0·05 meter per meter. The mud descends naturally. The chute may be raised or lowered according to any desired angle by means of two small hydraulic presses. The barge supporting the framework is provided with a turn-table, around which the chute may be revolved in any direction. The entire system is kept in place by four anchors. The operation of the dredge is essentially automatic, for the engineman who takes charge of the engine has only to turn the cock that allows of the introduction of steam into the cylinder, when the chain that carries the buckets begins its regular descent and ascent, and each of the latter brings up and empties into the chute 400 liters of sand that it has dug up from the desert. Between the excavation of the material and its deposit upon the bank there is no intermediate operation of transportation by punts, such as we shall describe for the dredging where elevators are employed.

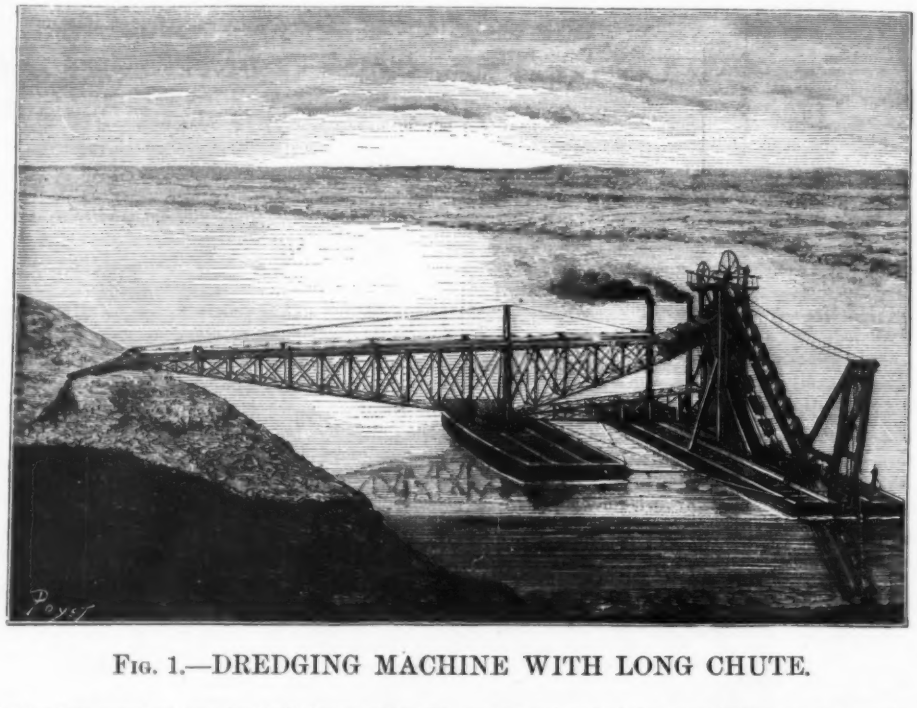


FIG. 1.—DREDGING MACHINE WITH LONG CHUTE.

However ingenious its operation, the dredging machine with its long chute did not permit of exceeding a certain limit in the height of the material emptied on the bank, and which was proportionate to the height of the chute itself at the summit of the excavating machine, and to the inclination indispensable to the sliding down of the sand that was helped along by the sweeping chain, or simply by workmen provided with hand-rakes. As the point of attachment of the chute could not be raised more than fourteen or fifteen meters above the level of the water, the height of the deposited dredgings could scarcely exceed five to six meters. It became necessary, therefore, to set up alongside of the dredging machine another arrangement that should permit of depositing a much greater height of sand. The apparatus adopted for this purpose was an elevator, which was constructed under the direction of Messrs. Borel & La-

FIG. 2.—ELEVATOR FOR LANDING AND DUMPING DREDGINGS.

valley, and which is shown in Fig. 2. In the first place, the reader will notice that the apparatus is a simple elevator, a sort of railway carried on an incline plane and supplied with material by dredging machines operating at various distances. The elevator consists of an irregularly triangular framework, whose base carries two tracks, over which run small box cars filled with dredgings from the canal. The shorter end of the frame points toward the canal, and the longer end toward the shore. The entire apparatus is arranged so as to be moved on a track along the bank. The operation is very simple: A punt filled with boxes containing the dredgings is floated under the lower end of the elevator, when by a simple maneuver the box is raised up and drawn along the inclined plane to the opposite end, where its contents are dumped on to the bank. The box is then slid quickly down again and replaced in the punt, and the remaining ones are then emptied one after another in the same way. The punt then returns to the dredging machine, and another one comes to take its place beneath the inclined plane. When a maximum height of fourteen meters has been reached in the embankment the elevator is moved along its track to a new position.

The two apparatus that we have just described served to dig the maritime portion of the canal into which the water had already been introduced; and thus was accomplished the long and laborious crossing of Lakes Menzaleh, Serapeum, Timsah, and the Bitter Lakes. In certain parts of the isthmus, where the necessary amount of water to float the dredges could not be introduced at the beginning of the work, it became necessary to have recourse to a third apparatus, the "dry excavator," which was devised by one of the section contractors, Mr. Couvreux. This apparatus is a dredge whose chain and buckets are maneuvered by a steam engine located on the side of the ditch to be dug. The entire apparatus is moved along on a railway, and the buckets emptied into cars that are drawn by a locomotive. The bucket frame is given the desired amount of inclination by means of the tackle that supports it. In measure as the ditch is enlarged the track is moved.

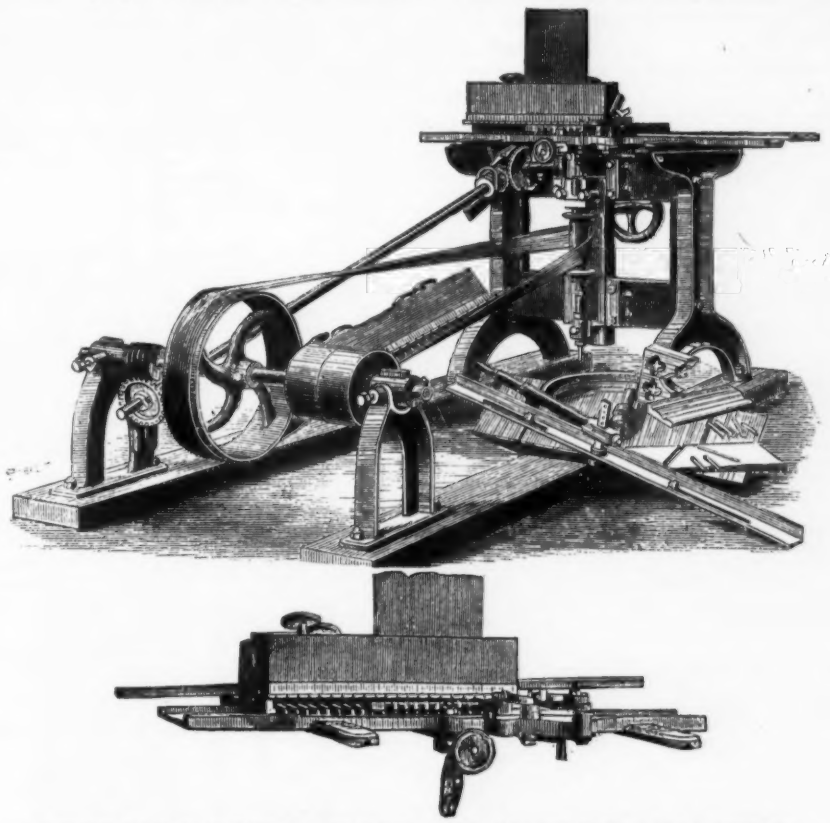
Along with these three principal apparatus that we have just described the gigantic Suez work necessitated the use of a colossal *materiel*, comprising ordinary dredges, elevators; excavators; punts for carrying the dredgings out to sea; flatboats and their boxes; steam cranes; iron boats for carrying coal; cars; locomotives, etc., etc., requiring a power of 10,000 horses, and consuming 10,000 francs' worth of coal per month. Twenty-two thousand laborers added their quota of intelligent power to this *materiel*, whose cost was figured at 40,000,000 francs. To the mechanical history of the Suez Canal it is impossible not to add what has properly been called the "heroic story" of the work, when, during the first period of operations, the power of machinery had not yet arrived to lend man its aid. The first attempt to cross Lake Menzaleh recalls the work of antiquity. Before the dredges could be introduced into these long marshes, where the layer of mud was covered with scarcely more than 20 to 40 centimeters of water, 400,000 cubic meters of the semi-liquid mud were extracted from a trench of four to five meters in width by fellahs, who scooped it up with their hands, pressed it against their breast to squeeze out the moisture and form it into solid lumps. Often even the mud was thrown on to the back of a fellah, who held it with his crossed arms and carried it to the bank as a hod-carrier would with his hod. The European laborer was rare, if not totally absent from these works, which remind us of the drudgery of primitive ages. Through machines and fellahs the entire work was finished in ten years. On the 25th of August, 1859, Mr. Lesseps struck the first blow of the pick on the desert beach where now stands Port Said, and which marked the mouth of the future canal, and on the 15th of August, 1869, Ali Pacha broke down the last rampart that composed an artificial barrier to the complete union of the two seas at Suez. Three months afterward, on the 17th of November, the fleets of all nations were traversing, in a triumphal march a thousand times grander than those of antiquity, the new route to the East.—*La Nature.*

DOVETAILING AND MOULDING MACHINE.

DOVETAILING machines are, as a rule, rather complicated mechanical contrivances; their mode of working is generally difficult to follow and still more so to describe. It may appear easy to say that the Tighe Hamilton machine cuts and dovetails by means of a drunken or wavy saw, but how this wavy motion is produced and how adjusted for different sizes, is anything but a simple mechanical problem. The little tool we are to-day illustrating may justly be called a simple one, for with it the dovetail cutter is nothing more than an ordinary rotary drill, wider at the end, tapering toward its shaft, and mounted on a vertical spindle. It will be readily understood that when a piece of wood is passed in a horizontal direction over this vertical cutter, the latter remaining in its position, but rotating rapidly, a dovetail groove will be cut in the wood. This is precisely the method of operation adopted in Mr. Anderson's machine.

In our illustration, Fig. 1, the vertical spindle driven from a countershaft fixed on the shop floor, is shown with the cutter mounted in it. For the purpose of cutting deep or shallow dovetails, the spindle can be made to rise or fall either by means of a treadle action, or by a handwheel, working a set of bevel wheels and a spindle, seen at the back of the machine frame. To cut dovetails of larger or smaller size, different cutters are inserted, the usual practice being to cut both male and female dovetails of the same size, with the same tool, thus insuring accuracy of fit. The table on which the wood to be dovetailed is mounted has a double motion like that of a slide rest; once it slides from back to front over the cutter and back again, during which period the cut is produced; next it slides at right angles, pitching the wood for the next dovetail. These motions are given to it by the small shaft driven from the countershaft by worm and wheel, and revolving, by means of a pair of bevel wheels, a short horizontal spindle fitted with a crank under the table. This crank works in a slot fixed to the table, and by properly proportioning this slot a slow feed and a quick return are produced. On the same short spindle are mounted two segmental screw disks working against a lug or pin on the sliding table, and by their revolution causing the table to be shifted the distance of the desired pitch to the left. To insure the exact position after this movement, and previous to the cutter performing its work, a spring pawl engages in a bar in which teeth are cut to suit the pitch the machine is set to work at, different bars being used for different size dovetails. It will be readily understood that by means of this machine dovetails can also be cut extending only half through the thickness of the wood; the bottom of the cut is in this case of course semicircular.

In addition to the work described above, this machine is well adapted for moulding work of all kinds and almost all dimensions. A variety of cutters will enable the operator to produce excellent effects, and the pattern being at the top of the wood, guided by some fixed point above, while the cutting takes place from the underside, the shavings do not interfere with the working. When used for moulding, the cutter spindle is raised and lowered by a foot treadle, and to insure even depth of moulding, is worked against a stop. Altogether, the machine is an exceedingly handy little tool; it performs its work rapidly and well, and is simple in its construction. A number of these dovetailing and moulding machines of various sizes are in use at different works, and are giving great satisfaction.—*Engineering.*



ANDERSON'S DOVETAILING AND MOULDING MACHINE.

THE SUSPENSION OF CARRIAGE AND CAR SEATS.

THE various ways that have been devised for suspending seats so as to render vehicles of all kinds agreeable to those who occupy them, have been infinitely numerous, and the improvements in our single steel springs are effecting a comfort that was unknown to those who sat in the coaches of the court of Louis XIV.

Mr. Edward Delessert proposes to give the most improved seat springs a still gentler motion by a mechanism that we shall describe in a few words. The system may be applied not only to carriages, but also to railway cars.

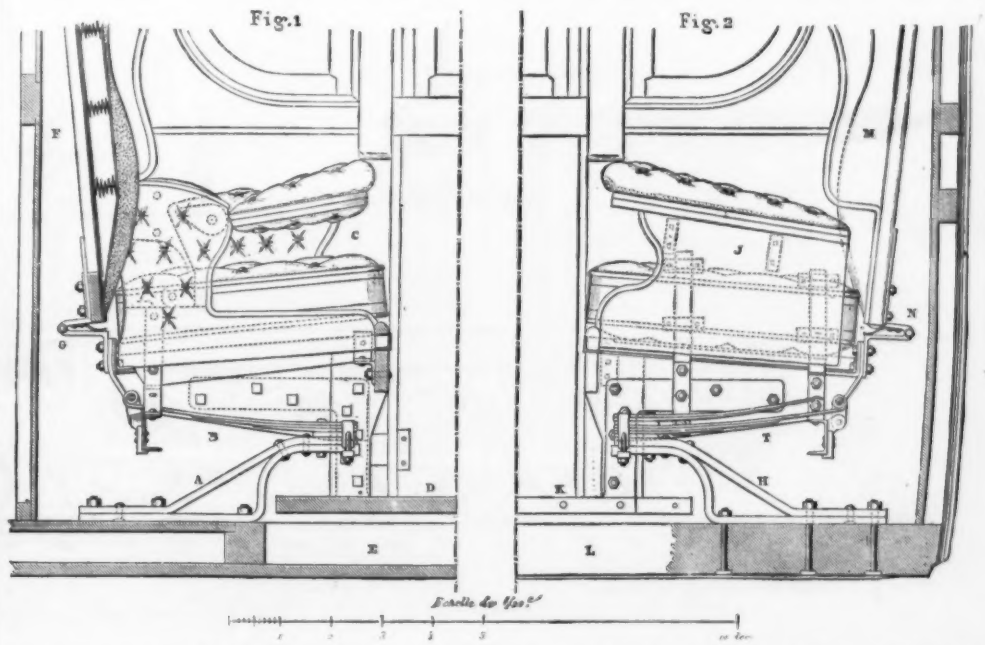
Let us consider a compartment of a car, which rests, with the rest of the car body, on the frame through the intermedium of springs. Suppose, now, that the seats, their backs, and the flooring directly beneath the feet form a whole which is sustained by springs affixed to those portions of the flooring contiguous to the sides of the car body, and we shall have a double suspension upon which will rest the entire body of the traveler. This is the principle of Mr. Delessert's invention, which differs herein from all other proposed improvements.

Hitherto, on the best railways, in order to reduce the motions of the car, an attempt has been made to support the seats or cushions by steel or rubber springs. The result of this has been that the feet of the passenger, resting on a flooring which had but a simple suspension, experienced a tiresome jarring, which, to invalids and nervous persons, proved almost insupportable.

We give herewith figures showing sections of a car of the first class to which the system has been applied. These, with the explanations appended and the few remarks above, explanatory of the principle, will enable the system to be readily understood. The weight of the suspension for a first class car is 445 kilogrammes, and for a second class, 364 kilogrammes. The cost is about 900 francs for a compartment car of the first class. This, doubtless, would be somewhat dear did not the expense find an offset in the greater duration of the car body through a reduction in jarring and jolting while running. On railways there are certain persons, such as post office agents, who work while the train is under way, and to whom as slight a motion of the car as possible is desirable. The cars provided for them are heavy, and are furnished with stiff springs by reason of the weight these have to support. The application of the Delessert system in such cases would prove very advantageous.

EXPLANATION OF THE FIGURES.

Fig. 1, section through the middle of the seat; A, support of the system; B, the suspension spring of the system; C, the seat; D, movable floor, forming a part of the seat arrangement; G, hinge of the seat with its back. Fig. 2, view of the end of the seat; H, support of the system; I, suspension spring of the system; J, arm of the seat; K, the movable floor; L, the stationary flooring of the car; M, movable back; N, hinge of the seat with its back. The upper part of the back rests against the side of the car.



DELESSERT'S SYSTEM OF SUSPENDING CARRIAGE AND CAR SEATS.

TWELVE-WHEELED FREIGHT LOCOMOTIVE FOR THE LEHIGH VALLEY RAILROAD.

We give this week views of one of a very powerful class of locomotives, constructed by the Lehigh Valley Railroad Company in its shops at Weatherly, Pa., from the designs of Mr. Philip Hofecker, the master mechanic of the Beaver Meadow Division. Three of these engines have been placed on the line, and are doing excellent service, two of them being built in accordance with our illustration, and the third having a somewhat larger boiler and steam dome.

The following are the dimensions of the engine in detail:

Kind of fuel used.....Anthracite coal.

WEIGHT AND GENERAL DIMENSIONS.

Gauge of road	4 ft. 8½ in.
Total weight of locomotive in working order, including two men	101,696 lb.
Total weight on driving wheels	82,432 lb.
Total wheel base	23 ft. 2 in.
Distance between center of front and back driving wheels	13 ft. 0⅜ in.
Distance from center of main driving wheels to center of cylinders	11 ft. 8⅛ in.
Length of main connecting-rod, from center to center of journals	7 ft. 9¼ in.
Transverse distance from the center of one cylinder to the center of the other	6 ft. 10 in.

Cylinders, Valves, etc.

Diameter of cylinders and stroke of piston	20 × 26 in.
Horizontal thickness of piston over piston-head and follower plate	4⅝ in.
Kind of piston packing	Cast iron.
Diameter of piston rod	3¼ in.
Size of steam ports	18 × 1¼ in.
Size of exhaust ports	18 × 2¾ in.
Greatest travel of slide valves	4⅝ in.
Outside lap of slide valves	11-16 in.
Inside lap of slide valves	1-16 in.
Lead of slide valves in full stroke	⅛ in.
Throw of upper end of reverse lever from full gear forward to full gear backward, measured on the chord of the arc of its throw	4 ft. 8 in.
Sectional area of opening in each steam pipe connected with cylinders	18 sq. in.

Wheels, etc.

Diameter of driving wheels, outside of tires	48 in.
Diameter of truck wheels	24 in.
Size of main driving-axle journal, diameter and length	6¾ × 7½ in.
Size of other driving axle journals	6¾ × 7½ in.
Size of truck-axle journals	4⅜ × 7½ in.
Size of main crank-pin journals	4⅝ × 4⅞ in.
Size of coupling rod journals	4 × 4 in.
Length of driving springs, measured from center to center of hangers	2 ft. 5 in.

Boiler.

Description of boiler, straight or wagon top	4 in. wagon top.
Inside diameter of smallest boiler ring	51 in.
Material of barrel of boiler	Iron.
Thickness of plates in barrel of boiler	½ in.
Kind of horizontal seams	Lap seams, double riveted.
Kind of circumferential seams	Single riveted.
Material of tubes	Iron
Number of tubes	199
Diameter of tubes, outside	2 in.
Distance between centers of tubes	2¾ in.
Length of tubes, over tube plates	10 ft. 11⅛ in.
Size of fire-box, inside, length × width × depth from under side of crown plate to bottom of mud ring	138 × 34 in.
Depth, front	4 ft. 4½ in.
Depth, back	3 ft. 7⅝ in.
Water spaces, sides, back, and front of fire-box	3 in., 3 in., 3 in.
Material of outside shell of fire-box	Iron.
Thickness of plates of outside shell of fire-box	⅜ in.
Material of inside of fire-box	Steel, crown sheet iron.
Thickness of plates in sides, back end, and crown of fire box	5-16 in., 5-16 in., ⅜ in.
Material of tube-plates	Iron.
Thickness of front and back tube-plates	½ in., ⅝ in.

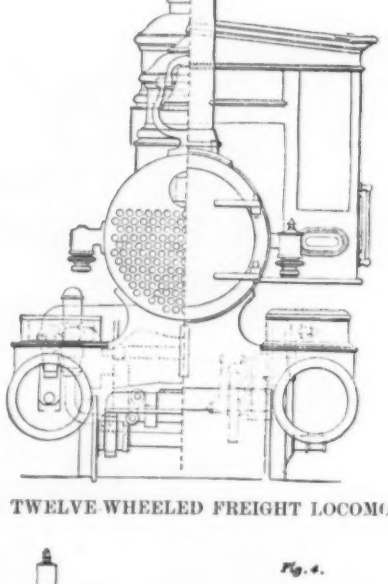
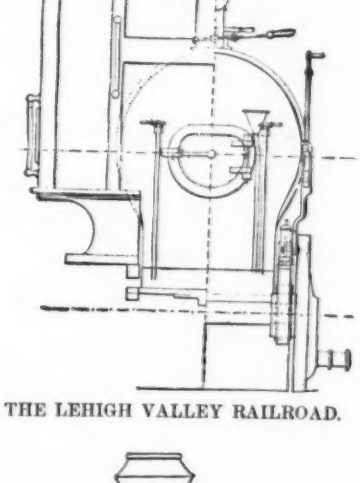
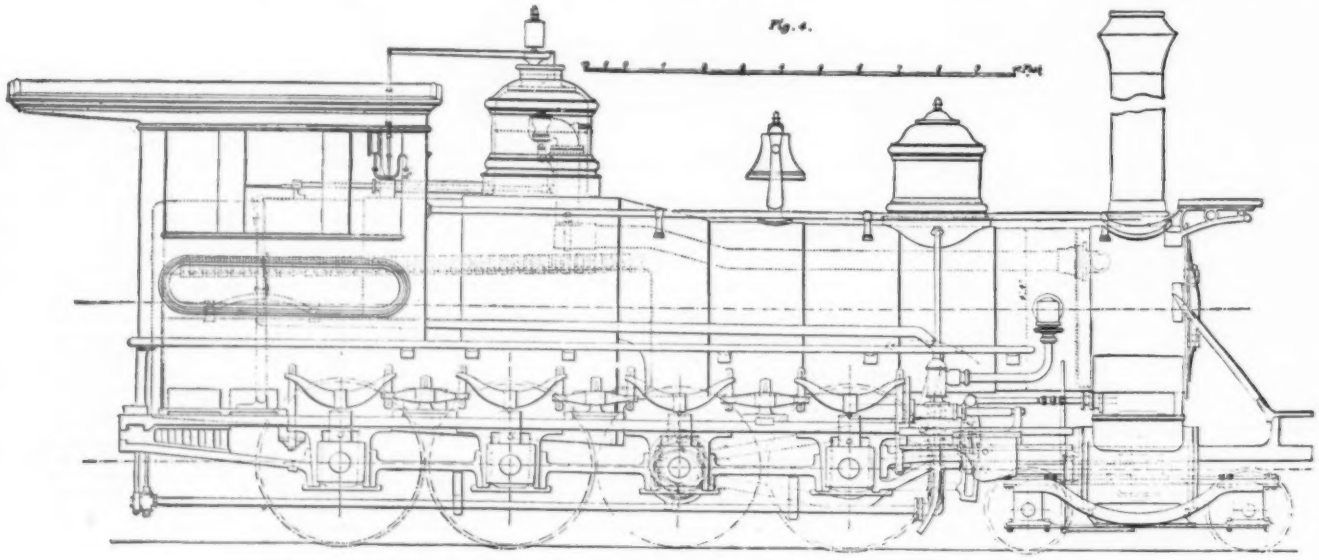


Fig. 3

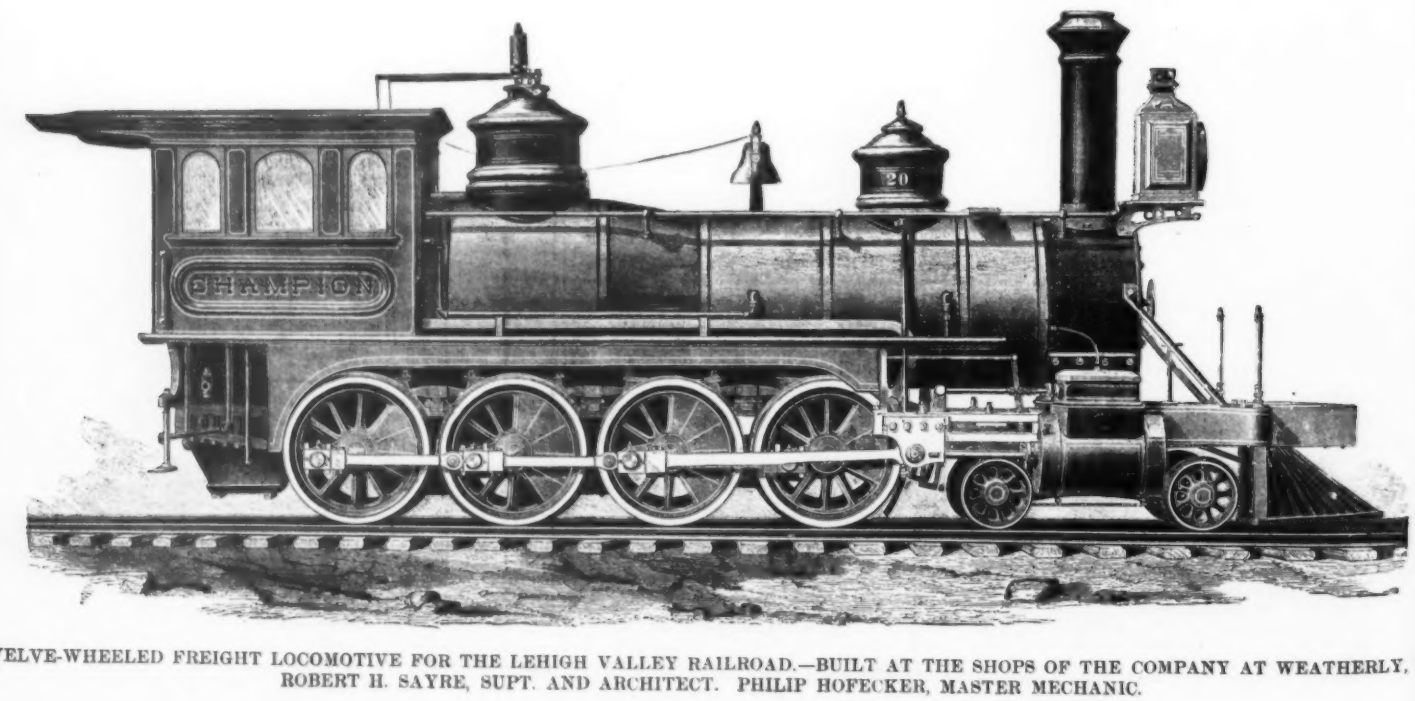


TWELVE WHEELED FREIGHT LOCOMOTIVE FOR THE LEHIGH VALLEY RAILROAD.

Fig. 4.



TWELVE-WHEELED FREIGHT LOCOMOTIVE FOR THE LEHIGH VALLEY RAILROAD.



TWELVE-WHEELED FREIGHT LOCOMOTIVE FOR THE LEHIGH VALLEY RAILROAD.—BUILT AT THE SHOPS OF THE COMPANY AT WEATHERLY, PA. ROBERT H. SAYRE, SUPT. AND ARCHITECT. PHILIP HOFECKER, MASTER MECHANIC.

Crown-plate stayed, with	Girder stays.
Diameter and height of dome	32½ × 30 in.
Maximum working steam pressure per square inch	125 lb.
Kind of grate	Water grates.
Diameter of tubes of water grate	2½ in.
Width of opening between tubes	1 in.
Grate surface	32 sq. ft.
Heating surface in fire-box	179 sq. ft.
Heating surface of the inside of tubes	995 sq. ft.
Total heating surface	1,174 sq. ft.
Kind of blast nozzle, single or double	Single.
Diameter of blast nozzle	5 in.
Smallest inside diameter of chimney	17 in.
Height from top of rails to top of chimney	14 ft. 7 in.

Tender or Tank.

Weight of tender, empty	23,400 lb.
Number of wheels under tender	8
Diameter of tender wheels	30 in.
Size of journals of tender axles, diameter and length	4×9 in.
Total wheel-base of tender	14 ft. 6 in.
Distance from center to center of truck wheels of tender	52 in.
Water capacity of tank (in gallons of 231 cubic inches)	2,575 gal.
Coal capacity of tender or fuel-bin	8,960 lb.

Engine and Tender.

Total wheel-base of engine and tender	46 ft. 9 in.
Total length of engine and tender over all	55 ft. 4 in.

This plan of engine is becoming deservedly popular, as similar engines have been built for other lines since the one illustrated was completed.

For the illustrations and data concerning these engines we are indebted to Mr. Robt. H. Sayre, superintendent and engineer, and to Mr. Philip Hofecker, master mechanic of this road.—*Railroad Gazette.*

EXPANSION OF IRON EMBEDDED IN BRICK-WORK.

AT one of the late meetings of the Engineers' Club of Philadelphia, on behalf of Mr. Thomas U. Walter, Honorary Member of the Club, the Secretary presented the following abstract from Mr. Walter's Fifth Annual Report to the Building Committee of Girard College, Philadelphia:

The expansible properties of *iron* having been a subject of considerable conjecture in reference to the bands for resisting the lateral pressure of the arches, I was induced to make an experiment for the purpose of discovering the actual difference of temperature produced in the middle of the walls, by the extreme heat of summer and the severest cold of winter.

Although I have never had an idea that any evil could possibly result from the expansion of the iron in question by an increase of temperature, the materials which surround it being subject to an expansion almost (if not quite) equal to that of the iron, yet the satisfaction to be derived from positive evidence on the subject is sufficient to give interest to the experiment; I shall therefore give a brief account of the manner in which it was conducted, so as to enable you to judge how far the result may be relied on.

The place selected for the experiment was the brick wall between the south vestibule and the large rooms; the thickness of this wall is five feet five inches, and its distance from the south front of the cell 26 feet; the sun had therefore full power upon it during the summer, and in the winter the whole building was covered with a temporary roof. I should also remark that the experiment was completed before any fires were made in the furnaces.

On the 23d of September, 1836, the temperature on the work being at 82 deg. Fahrenheit, a self-registering *minimum* thermometer was placed upon the iron band in the middle of the wall, and the brick work constructed as solidly around it as the rest of the building.

On the 29th of July, 1837, the temperature being again at 82 deg., a hole was made in the wall, and the thermometer taken out, when it was found that the register had descended to 42 deg. during the intermediate winter, the extreme cold of which was 3 deg. below zero: thus we find the greatest cold in the middle of the walls to be 42 deg.

On the 16th of January, 1837, the temperature on the building being 24 deg. Fahrenheit, a self-registering *maximum* thermometer was placed on the iron band in the middle of the aforementioned wall, on the same horizontal line with the other thermometer, and about 60 feet distant from it, a space having been left in the wall, when it was built, for the purpose, which space was walled up around the thermometer as firm and compact as the rest of the work.

On the 16th inst., the temperature on the building being again at 24 deg., the walling was taken out, when it was found that the register in the thermometer had gone up to 61 deg. during the intermediate summer, the greatest heat of which was 94 deg.

We have therefore 42 deg. for the lowest temperature of the iron bars, and 61 deg. for the highest, making a difference of 19 deg.

The expansion that an increase of temperature of 180 deg. produces upon malleable iron is given by Dr. Ure, in his Dictionary of Chemistry,* as follows:

From experiments by Smeaton $\frac{1}{779}$ of its length; according to Borda's experiments $\frac{1}{843}$ of its length; and according to Dulong and Petit $\frac{1}{814}$ of its length.

Mr. Hassler (of New Jersey), in his "Account of Pyrometric Experiments," read before the American Philosophical Society, June 29, 1817,† finds the expansion to be equal to $\frac{1}{818}$ of its length; and in a work on Natural Philosophy, by Biot,‡ we have the experiments of Lavoisier and Laplace, made in 1782, giving an expansion, under the same increase of temperature, equal to $\frac{1}{815}$ of its length.

The trifling difference in these results may be attributed to a difference in the density of the material.

Now, if 180 deg. will increase a bar $\frac{1}{814}$ of its length (this being the greatest expansion obtained by the foregoing experiments), 19 deg. will lengthen it only $\frac{19}{814}$; hence the bands around the rooms of the college (each being 54 feet long from the points of support), will be subjected to a difference in their length between the extreme heat of summer and the severest cold of winter, of $\frac{19}{14,956}$, or $\frac{1}{787}$ of an inch.

This being the actual difference produced in the length of the iron bands, by the greatest change of temperature to which they can be subjected, it remains for us to consider the expansibility of the materials with which they are surrounded.

A table on the expansion of different kinds of stone, etc., from an increase of temperature, is given by Mr. Alexander J. Adie, civil engineer, in a paper read before the Royal Society of Edinburgh, on the 20th of April, 1835,* in which he makes the expansion produced upon bricks by 180 deg. of Fahrenheit, equal to $\frac{1}{1115}$ of its length, or $\frac{1}{74}$ of an inch in 54 feet, under an increase of temperature of 19 deg.

If, therefore, the maximum expansion of one of the iron bands in the walls of the college is $\frac{1}{787}$ of an inch, and the brick work surrounding it $\frac{1}{74}$, the difference is then reduced to nearly $\frac{1}{78}$ of an inch; but if we consider that the variation of temperature in the interior of the wall is only 19 deg., while the exterior is subjected to the extremes of heat and cold, it will be obvious that the aggregate expansion and contraction of the brick work is even greater than that of the iron.

From these considerations, it is evident that not the slightest injury can possibly result from the use of iron in the construction of the college.

I am, gentlemen, very respectfully,
Your obedient servant,
THOMAS U. WALTER, Architect.

Girard College, December 30, 1837.

* Ure's Dictionary of Chemistry, page 272.

† Transactions of the American Philosophical Society—new series—vol. i., page 227.

‡ Physique de Boit, vol. i.

* See Journal of the Franklin Institute of the State of Pennsylvania, vol. xx., page 200.

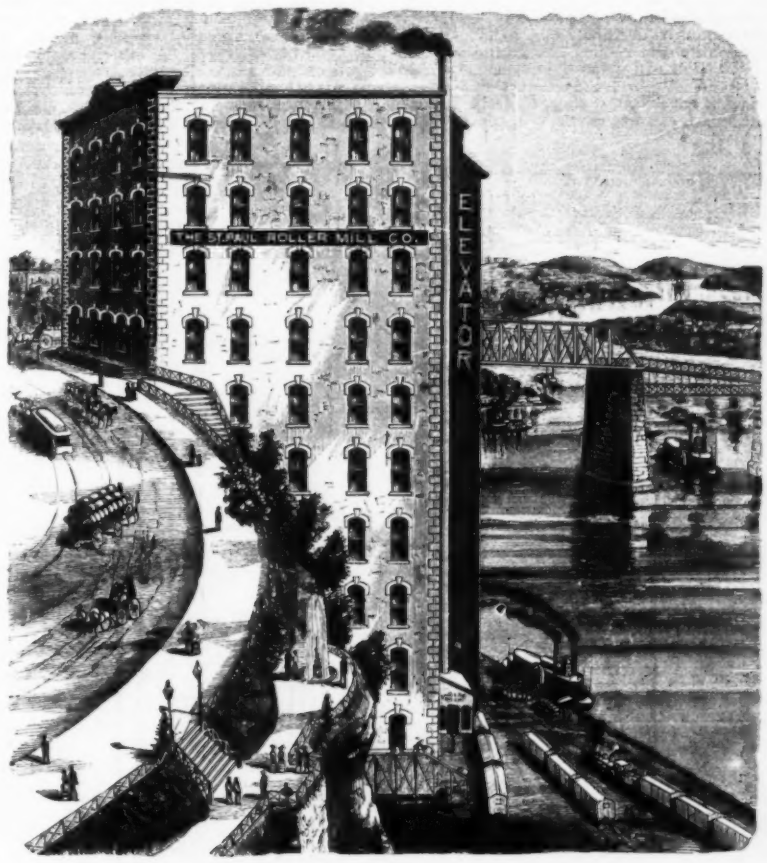
THE ST. PAUL ROLLER MILL.

WHILE there is an evident tendency in flour-milling, as in everything else, to centralize at certain points, there are so many places which possess certain advantages which the miller is quick to appreciate, that there is no danger of one or two cities or localities doing the milling for the entire country. No matter what advantages one point may possess, it is sure to have certain drawbacks from the miller's point of view, which prevent its absorbing too large a proportion of the milling business. The desirability of a point for merchant milling purposes is not dependent alone on its contiguity to supplies of raw material. Power, transportation facilities, and proximity to consuming centers, are all factors in determining whether a given locality is a suitable one for the continuous production of flour. Since this is so, our merchant milling industry must for ever be divided among the scores of cities and towns which possess in varying degrees the requisites just named.

Had it not been for its closeness to the great water-power of St. Anthony's, the City of St. Paul would long ago have been one of the largest milling centers of the Northwest. Located at the head of navigation of the Mississippi, with excellent railway facilities eastward, and in the heart of the spring-wheat country, of which she is the natural commercial metropolis, it is questionable whether the absence of cheap water-power places her at a disadvantage with any other point in the Northwest as a suitable location for merchant mills. The gentlemen composing the St. Paul Roller Mill Co. certainly manifested their faith in the advantages of their city in building the fine structure which is illustrated on this page; and the fact that the mill has been running steadily without losing a day throughout the dull spring just passed, seems to justify their estimate of the advantages of St. Paul.

The St. Paul Roller Mill was built in the fall of 1880, and ground its first flour in 1881. From our engraving the reader will perceive that the form of the mill is somewhat unique, architecturally. The building is built of stone, and is 90 by 40 feet in size, and ten stories high. In the rear of the mill is an addition and storehouse not shown in the illustration. The smoke-stack is probably the highest in the State. The peculiar form and location of the building were chosen with a view to enable the mill to avail itself of the advantages offered by proximity to the river, the railroad, elevator, and the street. But another very important purpose is served by the great height of the building on the river side—namely, that conveyers are largely dispensed with—thus economizing power, and a large amount of labor is saved by having the packing-floor below the grinding-floor, and the shipping-floor below the packing-floor. The flour does not even have to be rolled into the cars, but slides down an inclined plane right into cars on the track. Boats of the St. Louis lines land directly behind the mill, making the shipment of flour by river very easy. The fact of the mill's being located at the head of navigation gives it the cheapest freight rates to points down the river, while at the same time it procures wheat at the lowest prices. As a natural consequence, the mill has a large and profitable trade down along the river and through Iowa and Illinois. The products of the mill have been widely distributed, flour having been sold to go to far off Alaska, and to many European markets, while the brands of the St. Paul Roller Mill are well known in New England and through the Middle and Southern States.

Our readers are doubtless familiar with the machinery usually found in first-class roller mills, and any detailed description of the numberless appliances used in the St. Paul Roller Mill would be superfluous. We may state, however, that the mill contains much machinery that is peculiar to itself compared with other American roller mills. The mill has a capacity of five hundred barrels per day, although on good wheat its production has exceeded this amount by more than fifty barrels. Thirty-six double sets of rolls are used, including three of the Ganz ring rolls, imported from Hungary, from the famous foundry and machine works of Ganz & Co., at Buda-Pesth. These Ganz rolls are used for finishing, and we are told produce results taken in connection with the centrifugals, which are used for bolting after them, that are exceedingly gratifying. On the rolls for the first break the Stevens corrugations are used, and Ganz corrugations on the others. Great attention is paid to wheat-cleaning, and the system employed is the result of long and careful study and experiment. In addition to the ordinary separators, cockle machines and other cleaning apparatus used in modern mills, *tararas* constructed on the Hungarian model are employed, and we are assured with very satisfactory results, which have been especially marked the past year when there has been so much trouble from sprouted or grown wheat. There are other special machines employed in the mill which we have not space to describe here, but we may mention a special brush-machine made to order by Throop's Grain-Cleaner Co., of Auburn, N. Y., and used to follow the ending stone-reels, being provided for this purpose with extra long fibers.



THE ST. PAUL ROLLER MILL, AT ST. PAUL, MINN.

There are some points about the management of this mill which could be imitated by many other establishments with advantage. We refer to the close attention to those small expenses through which the profits of a manufacturing establishment often leak through carelessness on the part of the management. In this mill, on the other hand, every pint of oil used in any part of the mill is measured and accounted for in a monthly report by the oiler. The engineer, likewise, keeps a report in a neat form gotten up by the manager, showing the hours of time the mill has run, time of starting up and shutting down, delays, if any, with their duration and cause; also a detailed statement of any expenses incurred, besides the statement of fuel used by their 22 by 48 Reynolds-Corliss engine, and lubricating and illuminating oil consumed. Every week this report is submitted to the manager, and the average cost per barrel for the engineer's department figured out. In addition to this, a yield-book is kept in which the amounts of wheat ground and flour made are entered daily, and once a week all the offal is cleaned out and the yields and percentages figured up. One thing especially insisted on in the mill is cleanliness; and at whatever hour a visitor may enter the mill,

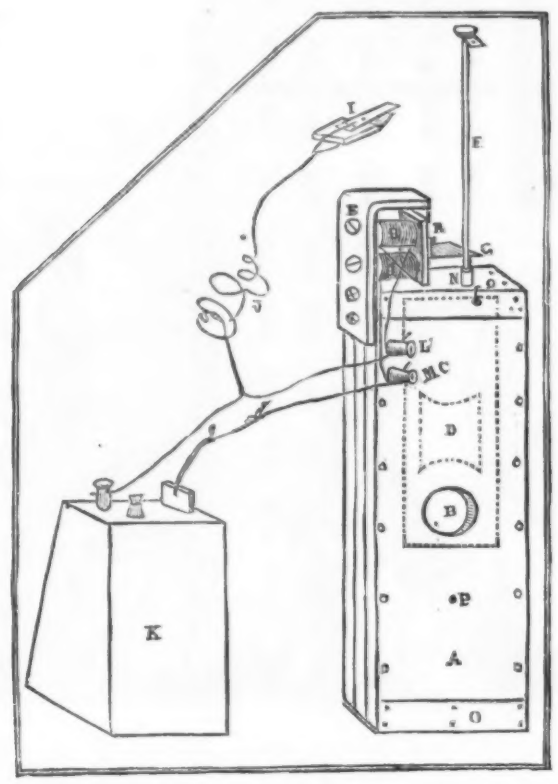
whether at noon or at midnight, it will be found as clean as a drawing-room, from top to bottom. This is done, not only for the sake of appearances, although this forms one motive, since the mill has many visitors from its being the only merchant mill in St. Paul, but also as a precaution against fire, as the manager is fully convinced that if mills generally were kept in as good a condition as his own mill, the liability to fire would be decreased and millers have less cause to grumble at the high rates of insurance which are always charged for mills. The mill is owned and operated by a stock company, counting among its directors and stockholders many of the leading citizens of St. Paul; but a controlling interest is held by Mr. Kingsland Smith, who is also general manager of the mill and its business. Mr. Smith comes from an old race of millers, his father, grandfather, and great-grandfather having been wearers of the white hat; the two elder ones on the genealogical tree were pioneer millers in Western New York, where Hiram Smith long held the supremacy. The father of Mr. Kingsland Smith was one of the first to break away from the prejudice against steam flouring mills, and twenty-five years ago built the first steam flouring mill in New York city, being afterward very successful, and running as many as four mills at one time. One of these mills, in 1864, was accounted the largest mill then in existence.—*American Miller.*

ELECTRICAL EXPOSING SHUTTER.

IN the construction of the shutter itself I have aimed at two things, viz., simplicity of construction and safety from light, and will now endeavor to describe the apparatus.

The diagram shows the whole arrangement in position for exposing a plate, the front being toward us. It is made of boxwood, and is in five pieces, viz., front, back, two side slips, and the drop slide in the middle, and six slips of metal about half an inch wide and one sixteenth of an inch thick; and four of these are riveted to the top and bottom of the front and back to prevent warping, and the remaining two from the top and bottom.

The shutter being fixed to the camera and everything in readiness the photographer can now retire to any required distance and watch his object coming into position. Keeping the clip, I, in his hand, and at the right moment by pressing the fingers, the contact is made; the magnet, R, is attracted toward H H, F is released, the slide, C, drops, and the exposure is made.



A, the front. B, aperture. C, drop slide, marked by dotted lines. D, aperture in same. E, electric attachment. F, brass rod one-sixteenth of an inch, fastened to the upper part of the drop slide, and having a milled-head screwed on to its upper end. G, metal catch screwed to the magnet, the edge of which presses into a small notch in F. H H, cotton-covered wire coils. I, the connecting clip, a square piece of ebonite about an inch long and one-eighth of an inch thick, having thin pieces of brass about two inches long (to which are soldered connecting wires) fastened to it one on each side. J, covered double wire of any required length. K, Leclanche's medical portable battery, made of tin (weight about a quarter of a pound, retail price about two shillings and sixpence). L and M, screw connecting lamps. N, brass collar through which the rod, F, works; it is fastened to the metal top, and assists in keeping F steady. A small gas-burner can be utilized for this purpose. O, metal plate to prevent warping (of which there are four), already mentioned. P, a small hole in which a pin is inserted to keep the slide in position for focusing. Q, metal plate covering the top; there is a similar one covering the bottom. R, magnet.

ELECTRICAL EXPOSING SHUTTER.

I may mention that the exposure can be regulated to suit the operator. If the most rapid motion be required attach a piece of elastic band to the top of F and to a small hook fixed to the top of the shutter. If an exposure, say, of a second, be required, incline the shutter a few degrees from the perpendicular, so that the motion of the slide may incline toward the horizontal. It can also be worked by hand.

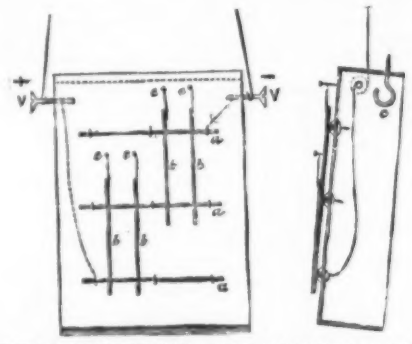
One battery I find will work the shutter, but for greater certainty I have two. They are placed in an aneroid barometer case, and can thus be carried about with ease; they can be hooked under the camera and are out of the way. My two batteries, case and all, do not weigh more than half-a-pound, and they will keep in good condition without any attention for (I believe) about two years.

I have made no mention of the position of the shutter, nor of the means of attaching it to the lens, as these are matters of taste, and the details may be varied to suit circumstances. Very simple arrangements will enable the shutter to be adapted to work either before or behind the lens.—*D. Edwards, in Br. Jour. Photo.*

CHEAP MICROPHONE FOR DOMESTIC USES.

A CORRESPONDENT of *La Nature* gives the following description of a cheap and easily constructed microphone for use in dwelling houses, etc. Into the circuit of a Leclanché pile of four elements, and of small size, there are interposed, on the one hand, the transmitter of sonorous vibrations, which will be described below, and, on the other, a pair of ordinary Bell telephones (12 francs per pair).

The transmitter is formed of a small fir-wood box without any cover. To the bottom of this, on the outside, there are affixed, by means of small brass wires passing through holes



CHEAP MICROPHONE FOR DOMESTIC USES.

made for the purpose, three small round plumbago rods, *a*, *a*, *a* (the harder the better), about from 0·5 mm. to 2 millimeters in diameter, and from 5 to 6 millimeters in length. These are placed about 3 centimeters apart. The two extreme rods are connected by means of brass wires, one of them with one of the two screws, V, fixed to the sides of the box, and the other with the other screw. The middle rod serves only for increasing the service of contact of the crayons with the vibrating piece.

Upon these rods rest four others, *b*, *b*, *b*, *b*, 5 centimeters each in length, and held by ordinary wires to pins, *c*, stuck into the wood. The box is suspended by means of the screws, V, from the extremities of the line wire.

A screw hook, *c*, from which any objects whatever may be suspended, allows the inclination of the box to be regulated, and consequently the amount of contact between the stationary and movable rods. The circuit conductor is a 9-10th millimeter copper wire, simply insulated with gutta percha, and wound for changes of direction around small ordinary screw hooks fixed to the lower part of the wainscoting. Its small diameter allows it to pass readily under doors. Under the influence of the hook's weight the box assumes a slight inclination, and the movable rods rest lightly on the fixed ones. The least sounds that are made in the room containing the apparatus are transmitted to a distant room, so that even the breathing of a child may be distinctly heard. The same is the case with words spoken at a distance of four or five meters from the box; if the sounds become louder the telephone will reproduce them to the listener without his having to apply his ear to it, and if still louder a spattering sound will be heard in the telephone. This latter inconvenience may be obviated by properly regulating the inclination of the box to suit the nature of the sounds that are to be transmitted. This is done by suspending from the hook, *c*, objects of more or less weight.

PHENOMENA OF INDUCTION.

WE find in the 111th number of Mr. Guillemin's *Le Monde Physique* a very interesting chapter on the phenomena of induction, and the author has there found a means of giving in a very well known part of elementary electricity a new form to the explanations that he has undertaken to make. This is the way in which he expresses himself:

"The phenomena of electrical influence or induction have, with those that we have studied in Book I., under the title of phenomena of magnetic induction, so great an analogy that it is impossible not to recognize the fact. A row of conductors placed one after the other in the presence of an electrized body, is comparable with the elements of a magnetic chain. Just as these latter acquire two poles, so placed that those of contrary name are turned toward each other, so are the conductors of this sort of electric chain that we are supposing all affected by two opposed electricities, or, in other words, are polarized in the same direction. This electrical state is temporary, like the magnetic state of soft iron, for it disappears as soon as the inducing body is removed.

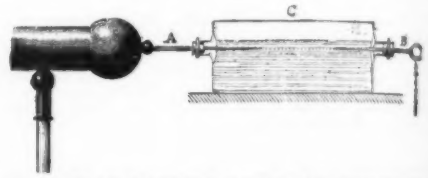


FIG. 1.—POLAR ELECTRIZATION OF MOLECULES.

"Such a polarization exists from molecule to molecule in every electrified body, whether a good or bad conductor; but there is between these two classes of bodies an essential difference. While in a good conducting body the separated fluids pass rapidly and easily from one molecule to another, by a series of successive compositions and decompositions, so that the state of molecular polarization is destroyed as soon as produced, in insulating substances the propagation of electricity is effected with a relative slowness which depends at once upon the intensity of the action exerted and upon the insulating power of each substance. Different experiments may be made to prove the polar electrization of molecules in non-conducting bodies. We shall describe a few:

"Into a vessel, C, filled with spirits of turpentine (Fig. 1), there are introduced small fragments of spun glass or flocks of silk. The vessel is pierced laterally by two tubes, which are traversed by two metallic rods, A and B, whose pointed extremities face each other. One of the rods, A, is made to communicate with a source of electricity, and the other, B, with the earth by means of a metallic chain. Then the floating fragments are observed to assemble from all parts of the liquid, and to form between the two points a continuous material line. This sort of an electrical chain offers a certain resistance, and if it be broken by means of a glass rod, it immediately forms again, thus indicating the molecular electrical polarization of the liquid which sustains its elements. If the insulating threads be replaced by small fragments of a conducting body (particles of gold, for example), a series of small sparks will be observed to leap along the chain. This experiment is due to Faraday."

The phenomena of molecular induction perform a very great *role* in all production of dynamic electricity, and too great attention cannot be paid to this. Many mysteries that puzzle savants would be cleared up if this important theory were prominently put forward. With motion we have electricity; with electricity we have motion; and with motion and electricity we have the most curious and surprising phenomena from all points of view.

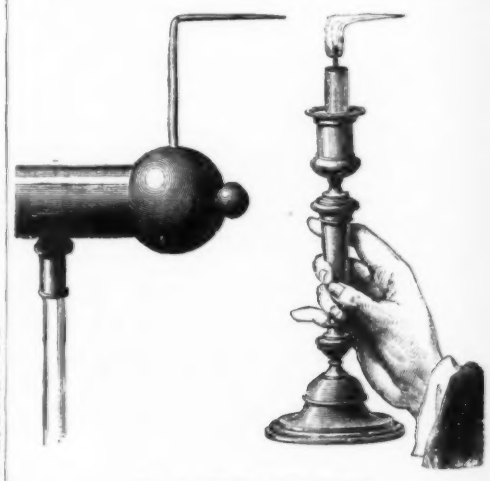


FIG. 2.—ELECTRIC WIND.

Experiments showing that molecules of air obey the action of electricity, and are repelled with sufficient force to extinguish a candle.

REACTION CURRENT OF THE ELECTRIC ARC.

By M. JAMIN and G. MANEUVRIER.

THE two alternating currents in opposite directions given by Gramme's self-exciting machine are absolutely equal; consequently they do not decompose water, and a tangent compass introduced into the circuit experiences no deviation, since the contrary effects which follow at very short intervals destroy each other. This destruction of the effects is maintained if we introduce into the circuit one or more burners, provided that the two carbons are equal, identically arranged, and are equally heated. If we introduce

eight to ten Bunsen elements into the circuit they give the compass, when the machine is at rest, a deviation d, and if it is in action a deviation d', absolutely equal to d. This equality proves that the resistance of the wires of the machine for a current derived from an exterior source does not change, whether the machine is at rest or in action. It proves, further, that the two effects of the machine and the battery are superposed and independent of each other. If we now suppress the battery and introduce into the circuit a burner formed of two unequal carbons, the one thick and the other slender, this want of symmetry suffices to determine a permanent deviation of the compass as if a battery had been introduced. The two systems of inverse currents given by the machine cease to be equal; that which sets from the thick carbon to the thin one prevails over that in the opposite direction. Hence there results a differential current, which is shown by the compass, and which is so much the more intense as the difference of thickness of the two carbons is greater.

ON THE MAGNETIC "AFTER-EFFECT."

By FELIX AUERBACH.

IN all the magnetic theories of Poisson and others, the magnetic state of a body at any time is supposed to depend merely on the magnetizing forces at this time.

Under "after-effect" are understood two kinds of phenomena. The one, the changing magnetic state of a body during the action of a constant magnetizing force, or after the force ceases to act; the other being the dependence of magnetic state not merely on the amount of magnetizing force acting at the time, but on the amounts of these forces which acted before this time, and the previous conditions of the body. As to after-effect in elastic phenomena and in magnetism, the author mentions the work done by Kohlrausch, Fromme, Meyer, Warburg, and himself.

The author has already considered, in a previous communication, "after-effect" of the second kind. The general question which remains to be answered is, how does the present magnetization, m, depend on the magnetizing forces $J_1 \ldots Jp \ldots J_3$ respectively, which have acted at a previous time when the magnetic conditions were $M_1 \ldots Mp \ldots M_3$, and this he has tried to answer. In the present paper, as the question is a complicated one, he gives a qualitative answer, reserving for a future communication his numerous tables of experimental results and formulæ. The arrangement of his experiments was the same as in his first researches. The body operated upon was a hollow soft iron cylinder, 5½ inches long, 0·69 inch in diameter, magnetized by means of a coil of wire. The following are some of his results: If the magnetizing force, i, following on a condition of no force, would produce the magnetization m_0; then, if besides the force i acting at present, a series of forces, $J_1 \ldots Jp \ldots J_3 \ldots$ acted previously, instead of the magnetization m_0, there would now be the very different magnetization m, the difference between them being the "after-effect" of the previous forces. J_1 is of importance in maintaining after-effect, so long as all the succeeding values of J lie between J_1 and i, but after any subsequent value of J lies outside these limits, it may be considered that no after-effect is due to J_1. Again, of two previous forces which lie upon different sides of i, the second alone is of importance if it lies further than the first from i; in every other case they are both of importance in determining the value of m; it is never the case that the first alone is useful. Permanent magnetization of steel is a special case of "after-effect," and its laws are merely special cases of general laws. Just as it was found that, when forces followed one another discontinuously, certain intermediate forces are of consequence, so it is found that, if the force alters continuously, the rate of change is without influence on the after-effect—at least, the influence is small in comparison with the after-effect itself. If the magnetic force be increased suddenly, a magnetization results which decreases in time, at first quickly, then slowly, and approaches a constant value, which is, however, greater than the constant value produced after very slow production of the same force. The rate change of force is only of influence on the "after-effect" of the second kind, when it is so great that it causes an after-effect of the first kind. Lastly: The magnetic after-effect is in no case very small in comparison with the magnetic effect itself, although it is always less, but between a value equal to the effect itself and zero it may have all values. It is not easy for it to approach the value zero. The author concludes by saying that no theory of the cause of the second kind of after-effect can be worked out till the phenomena of the first kind of after-effect are thoroughly mastered.—*Wiedemann's Annalen.*

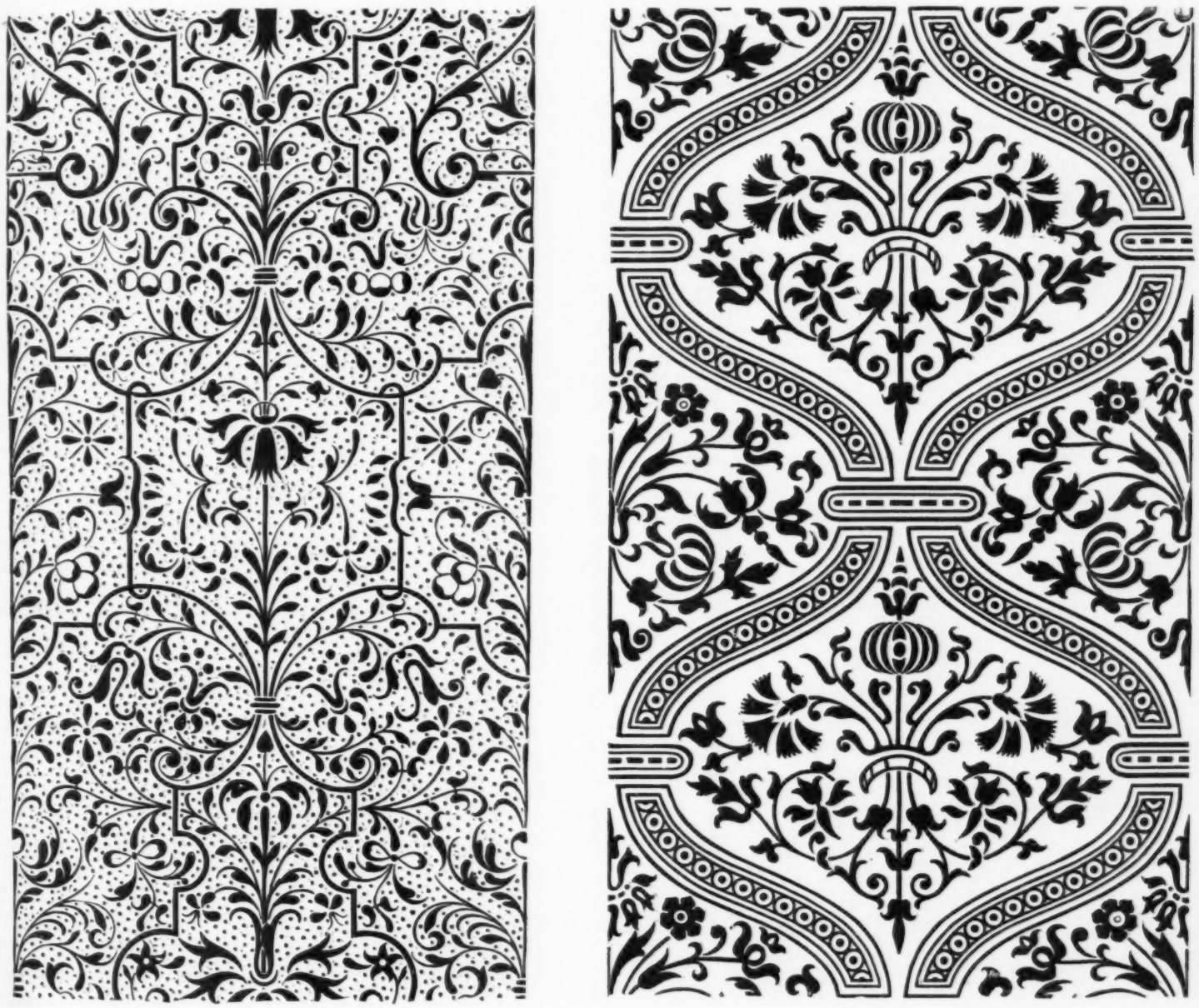
A BLIND MAN'S VISION.

M. J. PLATEAU, who for the last forty years has been totally blind, has just published a little paper on the sensations which he experiences in his eyes. He states that he has constantly in his eyes the sensations of light; his field of vision is divided into spaces, of which some are very clear and others somber or almost black. These spaces are not precisely limited, but run into each other at their borders; but what is remarkable is that their general tint alternates between gray and reddish. For example, if it be gray M. Plateau perceives now, in a few hours it will be red; then a few hours later the gray again, and so on. The reddish tint is that obtained by mixing pale rose-color, or rather flesh color, with a certain quantity of black. The relative arrangement of these different spaces is always the same, but the intensity of their tints varies. The central space shows itself sometimes very clear, sometimes very somber; above and below, as far as the limits of the visual field, there is sometimes clearness, sometimes obscurity. It is the same with the space to the left; there is generally a vertical, almost black band, and the space to the right of that as far as its limit is almost always clear and ruddy. These appearances seem to M. Plateau to fill the whole extent of his ordinary visual field. He believes the distance at which they are is small. These same appearances follow all the movements of the eyes as if they resulted from a modification of the retinas. It appears to M. Plateau that the two eyes do not participate in the same manner in the tints in question; but he is absolutely incapable of distinguishing what belongs to the one from what belongs to the other. He has not been able to establish any coincidence between the changes of the general tint and the work of digestion.

HYDROCYANIC ACID.

By C. BRAME.

HYDROCYANIC acid in vapor determines a scarcely visible turbidity in the white of egg or in a solution of albumen. Hydrocyanic acid dissolved in water precipitates abundantly pure albumen and its aqueous solution. The preservation of the bodies of animals poisoned with hydrocyanic acid is prolonged for a year. The rabbits, etc, poisoned with this acid, which figured at the Industrial and Artistic Exhibition of Tours, are still in good preservation, though they several times during the Exhibition underwent a temperature of 38°. After some months the bodies of animals injected or poisoned with hydrocyanic acid and preserved in stoppered vessels, lose all the odor of this acid, and take that of ammonium formiate, a salt which may be detected in the serous liquid. Ammonium formiate prepared directly with ammonia and formic acid gives a crystalline deliquescent matter, so that to obtain it the liquid must be evaporated over sulphuric acid with exclusion of air. In embalming with hydrocyanic acid it will be necessary to introduce into the body a small quantity of some matter which will harden on absorbing moisture (zinc chloride).



STUFF PATTERNS, FROM THE BAVARIAN NATIONAL MUSEUM IN MUNICH.

PORCELAIN.

PORCELAIN is made of a material which becomes vitrified and translucent by burning. It is distinguishable from pottery in its specific sense by its glassy fracture, its clear ringing sound when struck, the homogeneity of its outer and inner structure, and its resistance to fire, water, and acids, hydrofluoric acid excepted.

Porcelain is said to have been invented in China in the

fourth century A. D. The name is derived from *porcellana* (Portuguese), a fine white shell which was held to resemble the ware. The porcelain of China is believed to have been known to the Romans under the name of *murrhina vasa*, although they had no idea as to its mode of formation.

Oriental porcelain was imported into Europe by the Portuguese in the beginning of the sixteenth century; but this was not the first of the trade, though perhaps the first important venture in the way of porcelain merchandising. Early in the fifteenth century, the French King, Charles VII., had pieces in his collection; in 1847 Lorenzo de' Medici received several valuable porcelain vases from the Sultan of Egypt. The Marchese Campori, of Modena, cites a letter, written in 1567 referring to Bernardo Carnigiani as the rediscoverer of the art of making porcelain. This was more than a century before Botticher.

The incident which directed Botticher's attention to the subject was observing the contents of some crucibles in which some alchemical preparations had been heated. This was noticed to resemble porcelain, which then was a curiosity and of great value. The material which gave the peculiar character to the compound was ascertained to be a fine white clay, found on the road near Aue, which was excessively tenacious and clammy, but capable, when dry, of being reduced to a very fine powder, so that it had been used for hair powder. It proved to be kaolin.

The French porcelain works were first established at St. Cloud, in 1695, by Louis XIV.; at Vincennes, 1740; removed to Sevres in 1786.

The Meissen, Saxony, porcelain manufactory was established by Augustus II., Elector of Saxony, in 1710. Botticher invented the hard paste in 1706; the red ware, like jasper, in 1711; white porcelain, 1709; the perfect white kind in 1715. He died in 1719. Horoldt introduced gilding and painting in 1720; modeled groups in 1731; porcelain was made in England, at Bow, in 1698. Wedgwood ware was first patented in 1762.

Porcelain is divided into hard and tender. The former is made in Germany and in Asia, and the latter is held to include ironstone china and similar ware. The glaze is earthy and non-metallic.

Tender porcelain, on the contrary, consists of a vitreous frit, which is rendered opaque and less fusible by mixture with a calcareous or marshy clay. Its glaze is an artificial glass, composed of lead, silica, and an alkali. This porcelain would melt at the heat which the other requires to burn it.

The information gathered from the French emissary who went to China to surreptitiously discover the process of porcelain manufacture is published by the Royal Academy of Paris, and is in substance as follows:

There are three materials employed in forming the body of the ware; but all three are never used at once. The first is called petuntse. It contains certain shining particles, is fine grained, and is quarried from certain rocks. It is prepared for use by first breaking it with hammers, then grinding it in mortars with iron pestles, and, lastly, it is washed over, taking only the white creamy matter which floats on the surface, which, after being dried and pressed into small cakes, is fit for use.

The second material is kaolin, and appears to be porcelain clay, namely, that which results from the decomposition of feldspar. It is described as occurring in lumps in the clefts of mountains, covered with a reddish earth. It is prepared for use exactly in the same manner as the petuntse.

The third material is called hoache. It is used instead of kaolin. It has a smooth, soapy feel, and no doubt is either steatite, or soapstone, or agalmatolite. It is prepared in the same manner as the preceding. Porcelain made with this latter is much dearer than that made with kaolin. It has an exceedingly fine grain, and is very light, but at the same time more fragile, and it is not easy to hit on the precise degree of heat that suits it. For the finest porcelain, four parts of hoache are added to one of petuntse. Sometimes the body of the ware is made with kaolin; and then the article, when dry, is dipped in the hoache, brought to the consistency of cream; what adheres forms a thin layer, on which, when dry, are laid the colors and the glaze; and thus a porcelain finer than the common is obtained. Hoache is also laid with a pencil, before glazing, on those parts of the common porcelain that are intended to have an ivory white color.

For the fine koalin porcelains, equal parts of that substance and of petuntse are employed; for the less fine, two parts of the former and three of the latter. The ingredients being put together in due proportions, the mass is carefully tempered and kneaded by hand, and then the ware is wrought on the wheel, or for articles of irregular figure, which cannot be thus formed, is made by pressing the composition into moulds and then uniting the several pieces by moist clay. The piece, being formed, is very carefully dried, and is then covered with the glaze. The white semi transparent glazing is thus prepared: The whitest petuntse with green spots is pulverized and worked over, as already described; and to one hundred parts of the cream thus obtained is added one part of *che-kao* (burnt alum or perhaps gypsum), previously pulverized. A caustic potash lye is also prepared into which che-kao is stirred, and the cream thus produced is collected. The creams are then mixed together in the proportion of ten measures of the former to one of the latter. This composition it is which gives to porcelain glaze its whiteness and luster.

A brown glaze is made of common yellow clay worked over and brought to the consistence of cream and then mixed with the former glaze. If the brown glaze is not to cover the whole of the surface, wet paper is laid on the reserved parts, which, after the glaze has been put on and has ceased to be fluid, is removed, and such blank parts are then painted in colors and covered with the common white glaze.

When the glaze is thoroughly dry, the ware is put into the furnace for the first time, whence it appears that the ware is never in the state of biscuit—a circumstance in which the process materially differs from that adopted by the European manufacturers, who put on the glazing after the first firing of the ware.

The flux used with those colors that are laid on over the glaze is made of quartz, calcined and pulverized, and then mixed with ceruse in the proportion of one of quartz to two of ceruse.

Red is given by peroxide of iron, produced by calcining green vitriol; and a finer red is made of copper, but the particular process is kept a secret.

Petuntse and kaolin are both derived from feldspar, which consists of alumina, silica, and potash. Kaolin consists of decomposed feldspar, and petuntse is the powder of undecomposed feldspar. The radical difference seems to be that by decomposition and exposure to the air the kaolin has acquired plasticity, has become a clay. This being the case, it is easy to conceive the propriety of keeping the prepared clay in a condition to improve by exposure and age, before washing it. Marco Polo, who was from 1274 to 1291 in the service of Kublai Khan, the Conqueror of China, states that the heaps of porcelain were exposed in China for thirty or forty years before using; so that men gathered the materials for their children and grandchildren.

The other material mentioned is hoache, and probably, as the Pere d'Entrecolles remarks, is steatite, which is a compound of silica and magnesia.—*Pottery and Glass Reporter.*

THERMOMETER SCALES.

THE constant use of the Reaumur and Centigrade (Celsius) thermometric scales in the foreign technical journals and other publications is a daily annoyance to practical manufacturers as well as to the students of technical knowledge, of whom there are many now earnestly pursuing the work of Europeans in scientific research. For the benefit of those who cannot readily find a table of equivalents we have prepared the following table, and we have yet to see a precedent for such comparison not so complicated as to be of little practical use.

The zero of both the Centigrade and Reaumur scales is the freezing point, or 32° Fahrenheit. The boiling point of water at sea level is 100° Centigrade, 80° Reaumur, and 212° Fahrenheit. The zero of Fahrenheit's scale is 17·78° Centigrade and 14·22° Reaumur. All the intermediate degrees are therefore unequal except for every ninth degree in Fahrenheit's scale, descending from 212°. Separating the 32° of Fahrenheit, the proportions or relations of each scale to the other are 4° Reaumur, 5° Centigrade, and 9° Fahrenheit; but these proportions are only true for the difference between the freezing and boiling points, which is 180° Fahrenheit, 100° Centigrade, and 80° Reaumur. Any stated degree of Centigrade is therefore converted into its equivalent in Fahrenheit by multiplying by 9, and dividing by 5, adding 33°, which is the number of degrees in Fahrenheit below the zero of Centigrade. A degree of Reaumur is converted into its equivalent in Fahrenheit by taking $\frac{9}{4}$ and adding 32°.

E. g.

40° C. × $\frac{9}{5}$ + 32° = 104° F.
40° R. × $\frac{9}{4}$ + 32° = 112° F.
40° F. − 32° × $\frac{5}{9}$ = 4·44° C.
40° F. − 32° × $\frac{4}{9}$ = 3·56° R.
212° F. − 32° × $\frac{5}{9}$ = 100° C.
212° F. − 32° × $\frac{4}{9}$ = 80° R.

This table shows the rule applicable to the calculation of equivalents when no complete tabular statement is at hand. The whole table would be too much extended for our space, requiring 212 lines for the Fahrenheit scale, of which only 23 would find equivalents in even degrees of the other scales, and for the other scales at least 100 comparisons each would be necessary. With fractional degrees the comparison would be still more extended, but for most practical purposes the following comparison of even degrees will be sufficient, the intermediate numbers being calculated by the table above given—*Celsius* being always the same as *Centigrade*

TABLE OF THERMOMETRIC EQUIVALENTS.

Fahrenheit. Diff. by 9°.	Centigrade. Diff. by 5°.	Reaumur. Diff. by 4°.
212°	100°	80°
203°	95°	76°
194°	90°	72°
185°	85°	68°
176°	80°	64°
167°	75°	60°
158°	70°	56°
149°	65°	52°
140°	60°	48°
131°	55°	44°
122°	50°	40°
113°	45°	36°
104°	40°	32°
95°	35°	28°
86°	30°	24°
77°	25°	20°
68°	20°	16°
59°	15°	12°
50°	10°	8°
41°	5°	4°
32°	0°	0°
23°	−5°	−4°
14°	−10°	−8°
5°	−15°	−12°
−4°	−20°	−16°
−13°	−25°	−20°
−22°	−30°	−24°
−31°	−35°	−28°
−40°	−40°	−32°

Thus for every fourth degree in the Reaumur scale the equivalent is an even degree in Fahrenheit, and so for every fifth degree in the Centigrade (Celsius); but all other equivalents are fractional. But the conversion of either to any other is easy by the formulas above given; that is, by adding or removing the 32° of Fahrenheit, and then comparing on the basis of 9 to 5, or 9 to 4, and conversely.—*Textile Record.*

COATING SENSITIVE PLATES.

By C. F. MCWILLIAMS.

ASSUMING that the invitation so generally and generously extended to amateurs in your valuable journal meant just what it said, I am encouraged to jot down a few gleanings from a somewhat extended experimental experience, for the possible guidance of some who may have had less opportunities for observation than myself. In what follows, very little of originality will be found. Just how much has been originated, and how much *assimilated*, I cannot say. I propose to describe as briefly as possible my mode of coating plates.

First, I procure a champagne bottle, from which I cut the bottom with the aid of a hot poker; then into the neck I fit a hardwood plug, letting it project, cork fashion, about one inch. I next take an ordinary flower pot, enlarge the central hole in the bottom, and into it fit the projecting plug water-tight. Through the plug I drill a hole large enough to receive a one eighth inch glass tube, which extends three-quarters of an inch beyond the wooden plug, and to which I attach a piece of pure rubber tubing. A wooden spring clip completes this portion of my apparatus.

For five cents, at any of our furnishing stores, may be procured a window cleaner or squeegee. On the rubber blade of one of these I draw a closely fitting chamois cover. This, at an expense of next to nothing, completes my apparatus.

Now, to use. Suspend the flower pot containing the inverted bottomless bottle, by means of wire, over your coating table; fill the pot nearly full of hot water, attach the spring clip to the rubber tubing, and pour the melted emulsion into the bottle. Pour a very little emulsion into a shallow glass dish set in warm water, and into this put the squeegee, which should be as long as your plates are wide.

Everything being in readiness, take a plate on your holder—if you have one, if not, the finger will answer almost as well—draw the squeegee lightly from end to end, hold under the rubber tubing, and slightly press the clip. You will find the emulsion will flow smoothly and evenly up to the very edges of your plate. No need of glass rods, with their dust accompaniment, or anything else. No need of measuring even, as a very little practice will enable one to gauge the amount very accurately, as the emulsion forms a circular pool in the center of the plate each time.

With this simple apparatus I find no difficulty in coating thirty 5 x 8 plates (all my drying box will accommodate) in half an hour. An ounce of home-made emulsion, which is usually much richer in silver than the commercial article, ought to coat four 5 x 8 plates. A rich emulsion and a thin coating lessens very much the chances of frilling or blistering.

I hope the crudity of this description will not deter my fellow workers from a trial of it.—*Photo. Times.*

[Continued from SUPPLEMENT 346, page 5513.]

ON THE CONDITION AND CHARACTERISTICS OF SOME OF THE NATIVE TRIBES OF THE HUDSON'S BAY COMPANY'S TERRITORIES *

By JOHN RAE, M.D., LL.D., F.R.S., ETC.

IN my time many Indians from inland districts came annually to Moose in the summer, as crews of the canoes that brought down the furs for shipment to England. These were of mixed tribes from Abitibbi and Temiscamingue, large powerful men generally, but not so good looking as the Crees. It was a very old custom to give to these voyagers about a pint of weak rum each, as a "regale" on arriving at the depot. If they did not get this, they would have felt themselves defrauded of their rights, just as a sailor in our navy might now do, if his grog were stopped without cause. In the earlier years, the Indians always took this allowance of rum, which led to a certain amount of intemperance—but never to any quarrels or injury to any one. Tea, sugar, or tobacco, to more than the value of the rum given, were invariably refused.† In a year or two the conduct of these Indians wholly changed for the better. They almost invariably accepted the substitute offered for the rum, and the one or two who did continue to take the "fire water" used it in small quantities at a time, so that it produced no bad effect. These Indians, during their stay at Moose, met every morning and evening in a large tent, where one of their number read or spoke the service they had been taught, in the most exemplary manner, and then all joined in singing a hymn in their native tongue. They were, at the time, hundreds of miles away from the priest who had worked this good work among them, so that they were in no way coerced by his personal control. The Catholic priest is, of all others, the missionary who most rapidly and powerfully acts upon the mind favorably, and hence the life, of the Indian. His life of celibacy, the show and ceremony connected with the form of worship, his facility of adapting himself to the position in which he is placed, and, last of all, the common practice of the priest in learning the language of the tribe among whom he is to live, before ministering unto them, gives him a power and influence which few missionaries of other denominations possess. It was Father Mathew, many years ago, that converted the Iroquois, in the large village of Kauknawaga—one of the most drunken tribes in Canada—to temperance or total abstinence.

The Crees, when engaged in service, make faithful and obedient followers. I had two—Mistegan and Nibitabo—as hunters and boatmen, with me in the Arctic, and would never wish for better or more willing servants. Mistegan was one of the best boat and canoe men I ever saw in running a rapid, which requires much skill and practice; he was a good shot, an admirable snow-shoe walker and sledge hauler, and had great powers of enduring cold, as the following instance will show. He was with me one winter, in the barren lands northeast of Bear Lake, deer shooting, and one evening he did not return to camp.‡ I felt anxious about him, as it was very cold, at least 50° below zero, or 82° of frost, and he had neither blanket nor ax to cut wood with him. The night passed, and a great part of the following day, when at last, late in the evening, our hunter came in with half a deer on his back. His story was that having wounded a deer he followed on its track a long way before being able to shoot it. He was both hungry and thirsty; the former he relieved by eating the marrow from the leg bones of the deer he had killed, the latter he quenched by roasting a piece of snow before a small fire, which he was enabled to make by breaking a few branches off a small pine tree, and catching the water as it trickled down in a piece of the deer's skin converted into a cup. The man was none the worse for his night's outing and his very long walk.

Many attempts have been made to induce the Crees to cultivate the soil, and raise grain and vegetables, as an addition to their animal food. That this should have proved a failure on or near the shore of Hudson's Bay, is not surprising, for although the southern part of the bay is further south than London, the climate is very much colder, chiefly because of the almost constant presence of ice all the summer, which acts as a kind of refrigerator. But even were the circumstances more favorable than they are, I, as an old sportsman who has roughed it occasionally, nearly as much as the Indians, can quite understand their preference for the more stirring, varied, and exciting life of the chase, although often accompanied by short commons and not a little suffering. The Crees have no chiefs, the fact being that they now seldom or never band themselves together beyond a family or two.

Having occupied so much time with this one tribe, I must take a long leap to their first cousins, the prairie or plain Crees, passing by the Saulteaux of Lake Superior, and one or two other small bands of natives, of whom I personally know little. The manner of life of the prairie Crees differs in almost every respect from those frequenting the woods. While the latter travel wholly on foot, or during the seasons

* A paper read before the Society of Arts, London, March 21, 1882.

† I believe there is no rum now given, but even in former days, the total quantity supplied to an Indian in twelve months did not equal that imbibed by what would be considered a temperate English or Scotchman during a week or ten days.

‡ Our camp was merely a piece of ground from which the snow was dug away, then some branches spread to form our bed, no tent, and only a scanty fire, as wood was not abundant.

of open water in canoe, their living consisting of a great variety of fish, flesh, and fowl, the prairie Crees perform almost all their locomotion on horseback, except on particular occasions, when much caution is required, on the war-path, or on a horse-stealing raid. These horsemen, while resembling in some degree the wood Crees, are markedly different in appearance, being of slighter build, more wiry, and smaller limbed; their dress is almost wholly of leather, made from the skins of the buffalo, which, when numerous, supplied nearly all their wants, of bedding, clothing, moccasins, thread, etc. With the surplus meat and robes, combined with a few furs, usually of the coarser kinds, they purchase their kettles, axes, knives, tobacco, guns, and ammunition, although the latter two articles were not absolutely necessary, bows and arrows being very efficient weapons for buffalo shooting. To send an arrow right through a buffalo was not considered a very wonderful feat, but only done to show strength and dexterity, as it was preferred, for obvious reasons, to leave the arrow in the poor animal. As weapons of war in their fights with their enemies, the Blackfeet, guns were in demand. A Cree is seen to the greatest advantage when mounted on a spirited little horse, and in full dress (horse and man)—a fine subject for the artist! Yet, as horsemen, the Crees are often excelled by their half-breed brethren. This tribe are probably now some 3,000 strong or less, and have always been on friendly terms with the Hudson's Bay Company's people, in whom they have great confidence—a fact recently recognized by the Canadian Government, who most gladly called in the aid of some of these officers (notably Messrs. William Christie and James Mackay) in making the treaties for the sale of the lands of this and other tribes.

A Mr. Rowand, many years in charge of the Great Prairie District, gained much influence over these Indians, and, among other hobbies, took great delight in vaccinating them by the hundred when a large band visited Fort Edmonton. He used to make an oration to the chiefs, telling them that vaccination was a great medicine, and that it would save them from a terrible disease; so that they and their followers submitted readily to the operation. Some forty-five years ago, when small-pox spread as a scourge over the prairies, Mr. Rowand's precautions saved this fine tribe. The disease was first communicated from people in a steamer to Indians of the Missouri, in the United States. These sickened, and a great many died. While suffering from the malady, a party of their next-door neighbors, the Assiniboines, numbering thirty, took advantage of the opportunity to steal the horses of the sick and dying. They were successful in carrying off a valuable booty, but they took with them the small-pox also; two-thirds of the robbers perished on their way back, and the survivors had to abandon their spoil, but carrying the disease with them to the camp, where it made great havoc. The young men of the Cree tribe could not resist the tempting opportunity of stealing some of the Assiniboines' horses, and did so without any fatal results, as the vaccination protected them. The plague was stayed, and did not proceed further north, although it spread along the American lines, throughout the plain tribes, to the west of the Rocky Mountains, down to the Pacific, and then north from Vancouver Island to the Russian settlements. Of the Mandans, so ably described and finely illustrated by Catlin, only twelve remained, and a party of Sioux went to extinguish this remnant of that once great tribe. I assume that since the death of Mr. Rowand, a good many years ago, vaccination has not been so closely attended to, for during an epidemic of small-pox that recently visited the prairie tribes, causing great mortality, the Crees suffered as much as any of the others.

In the probable rapid settlement of the great northwest prairie lands, the question of what is to be done with the various tribes, consisting of Blackfeet and Blood Indians, Crees, Assiniboines, and Sioux, numbering in the aggregate from 12,000 to 14,000, is a very serious and important one. It is very evident that when the larger game (buffalo especially) become all but extinct—and they are now very scarce—these Indians must have something to live upon, and the most ready resource (to them) will be the flocks and herds of the settlers, unless other means are provided. So far, the Canadian government seem to have taken the very best possible means of meeting the difficulty. Reserves of land in favorable localities have been set aside for the Indians; farms have been established with the special object of teaching them husbandry; the requisite agricultural tools have been supplied, so as to combine stock-raising with agriculture, the former pursuit being probably much the most suited to the tastes and habits of the Indian. At present the more turbulent of the natives are kept in order by a very efficient corps of mounted police, three hundred or four hundred strong, who have hitherto done their work remarkably well. A strong detachment of these are always in attendance at the annual payment of annuities to the Indians, and, while protecting the agents, at the same time prevent disreputable traders from bringing spirits to sell. If any such are discovered, the whisky-cask is smashed, and all the owner's property confiscated.*

The Assiniboines, or one band of them, calling themselves the "young dogs," a mongrel lot indeed, are the most disreputable Indians on the prairies, and gave a hunting party which I accompanied, about twenty years ago, much trouble by their persistent efforts to steal the horses (some of them valuable animals), in which they on one occasion very nearly succeeded. Our guide, to whom the horses belonged, was extremely annoyed, not only from the fear of losing his property, but also from the Indians constantly hovering near us, scaring the game away. At last the guide (McKay) adopted a plan which proved eminently successful. Among other peculiarities of the Indians, there is one which men of my profession should consider extremely praiseworthy. They have a great respect and regard for a medicine man, especially a white one, not unmixed with a wholesome fear, and it was this last feeling which McKay, without my knowledge, brought into action. On these Indians first coming to see us, they were suffering much from ophthalmia, and I gave them some eye-wash. On coming to our camp some days afterward, while I was absent shooting, they told our guide (who spoke their language fluently) that their eyes were very much better, but that they wanted some more medicine. McKay told them the doctor (meaning me) was very clever and kind and good, and that he could cure their eyes, but that he was very angry with them for following us, and preventing us from hunting, and that if they continued to do so, he might perhaps get more angry, and make his medicine destroy their sight altogether. I came into camp before these Indians went away; they were a powerful, but extremely repulsive looking lot, and I could not account for the timid and alarmed manner in which they looked at me, in strong contrast to their former somewhat insolent demeanor to all of us. When shaking hands they actually trembled. On speaking to McKay on the subject, he laughingly told me the whole story, at which I was much displeased, although the ruse was most effectual, for we saw no more of our troublesome visitors. During much intercourse with Indians and Eskimos, I have always avoided making any statement to them that in any way deviated from fact.

The assumption of, or having ascribed to one, powers one does not possess, is not only wrong in itself, but leads to unpleasant consequences. A distinguished naval officer, when on Arctic service, made the Eskimos believe that he possessed supernatural powers; that the great guns when fired (this was done for some experiments on sound) gave information of the stealers of certain things from the ship, etc. One of the officers, on going one morning to the snow-huts of the natives to obtain a guide, was surprised by all the men rushing out of their igloos, furiously brandishing their spears and lances. The lives of this officer and his companion would probably have been sacrificed in a moment but for the courage and address of one of the women, who ran fearlessly up to the officer, and explained the cause of the excitement. That morning a stone, carelessly placed, had fallen on the head of a child, and killed it; and this the Eskimos attributed to the supposed supernatural powers of the Kabloonans. The officer knew enough of the language to give an explanation, and peace was at last restored.

A somewhat similar case, which terminated more fatally, occurred in British Columbia, in 1864. A party of men were road-making for a Mr. Waddington, and when winter began, they deposited a quantity of provisions in their log-hut, fastening the door. When they returned, in the spring, all, or part of the provisions had been stolen; and the white men accused a party of Indians whom they knew well, and were on friendly terms with, of the theft, and demanded payment from them. The Indians stoutly denied the accusation, on which one of the road-makers said, "If you do not pay us, we will bring that disease among you," at the same time pointing to one of his comrades that was deeply marked with small-pox. The Indians went away, held council, and came to a decision that as this terrible disease would destroy themselves, their wives, and children, they would be beforehand with those who threatened them. The very next night, at a given signal, the tents of the whites were simultaneously thrown down, and every man, with one exception, stabbed while helplessly lying underneath. The man who escaped happened to sleep that night not in his own tent, a circumstance not known to the Indians, and when the tent fell upon him, suspecting danger, he kept perfectly quiet, and remained so until he supposed, from the silence, that the Indians had gone away. He then crawled cautiously from the tent, and made a rush for a river near, but the Indians were at his heels, and as he was dropping himself from a branch into the water, a blow with a knife or an ax was struck at his hand, which disabled it, yet he managed to swim across and get away. I saw these Indians at Fort Alexander when brought in as prisoners. They all protested that they did not steal the provisions, and they had now given themselves up to save their wives and children from starvation.

I have now to describe briefly an Indian tribe, differing much in various ways from those already spoken of—the Dog-ribs or slaves, numbering perhaps about one thousand. This tribe frequents the lands on the borders of Great Bear Lake, to the south and east, and also the neighborhood of the McKenzie River and its tributaries. During two winters passed at Fort Confidence, on the east shore of Bear Lake, I saw much of the Dog-ribs, or "slaves" as they are called by the Copper Indians, who hunted for Franklin's overland party in 1819–21, and who used to tyrannize in the most cruel manner over the Dog-ribs, carrying off the finest of their young women, and robbing them of their property whenever they had a chance. At last, after much suffering, the slaves combined, and formed a plot with much secrecy for the destruction of their oppressors. This plan was so effectually carried out, that the greater part of the Copper Indians were killed, with but slight loss to their enemies, who were thus relieved from constant dread and trouble, for the remnant that escaped have never recovered their former ascendency.

The Dog-ribs, both men and women, have bright and sparkling eyes; are pleasant, cheerful, and lively, but are much addicted to falsehood and exaggeration, given to panics on the shortest notice, and for the slightest cause; some unpleasant dream, or the marks of a strangely-shaped snowshoe in the snow, will drive them from their hunting-grounds to the Fort in great alarm, with rumors and stories of the most wonderful kind, and it is impossible to convince them that there is no danger, and nothing but stopping their rations will make them proceed to their hunting-grounds again. They have some good qualities, however, being cheerful and pleasant companions, ready to go with the white man anywhere. They are kind and indulgent husbands, the wife having, in most cases, much influence, possibly because it is not unusual to decide the right to a wife by a wrestling match, the lady sitting by, an apparently careless and indifferent spectator of the struggle for possession. There is, I am told, no other ceremony than that the victor, whether her former husband or not, claims his wife.

All the superstitions of these poor people are most injurious to themselves—for instance, they will never tame a deer, as they think the doing so would bring death or misfortune; otherwise they might domesticate the reindeer, as the Lapps do, and have the means of a constant supply of food; for the barren lands of Arctic America are quite as good feeding-grounds as the shores of Lapland and Siberia.

They have another most unfortunate practice, which it has been impossible to break them of. On the death of a near relative they destroy every article of property of value they possess, retaining perhaps an old deer skin robe and a few other articles. I had a curious example of this absurd practice. On our way through Bear Lake, in 1848, to Fort Confidence, Mr. Bell met, on the shores of the lake, a fine old Indian perfectly destitute, except a dirty, worn-out robe, a wretched canoe, and a few fathoms of net. He was considered a well-to-do Indian, but having lost his wife, all his property was consumed. Being well known to the guide as an excellent fisherman, he was taken to the Fort, and installed in that office, in which he did his work admirably, catching more fish than the regularly-engaged fishermen, probably because he knew the lake better. He was a great favorite, and when we left the place, in 1849, he was furnished with a good supply of everything he required, besides being fairly well paid for the fish he had caught.

It happened that I had to return to Bear Lake in 1850, and in going along shore, we again found our fisherman as poor and destitute as he had been in 1848. He had lost a daughter by death, and showed his grief in the usual wasteful manner. He was again engaged for his old duties, which he performed satisfactorily, and he was again placed in comfortable circumstances in 1851, but if another death occurred, there would be another destruction of property. These two examples will illustrate the difficulty that the Hudson's Bay people have in dealing with these Northern Indians. Supposing that this old fisherman had been an active and good fur-hunter, the property destroyed, to the value, perhaps, of £10 or £20, would not have been the Indian's but the Company's, for which they would have been paid in the spring, by the furs killed. But as the Indian who loses a relation does not hunt during the season that the loss occurs, he comes back to the Fort destitute, and must have a fresh stock of goods on credit, for the winter, and may have to be fed gratuitously for some time in addition, for it is the universal custom, that if starving Indians come to a trading post, they are fed without payment until able to return to their hunting grounds, or if not able to come to the Fort, food is immediately sent to them.

(To be continued.)

* This is a very different state of things from what is *now* or *was*, some years ago, common on the south side of the boundary line, where, on similar occasions, the Indians were often drunk for days.

EDUCATION IN THE UNITED STATES.*

THE great work of the American Bureau of Education continues, like that of a large Reference Library among men who know its value. About 100 inquiries a day are addressed to it, and 150 letters of information are sent out on subjects varying from the Semitic language to dress-making, and including everything that comes within the limits of education. Its latest report, in which everything is tabulated, down to the opening of a normal summer school only kept open for four weeks, and in which attention is called to many matters of special interest, cannot be gone through without advantage to educationists in any civilized country, and most of all to those in our own.

If we are accustomed to think that Americans look upon their country with complete satisfaction, and as standing ahead of the Old World, more particularly in the matter of education, we shall not find such self-praise in the Government reports. A very interesting *résumé* is given of what foreign countries are doing. Attention is called to the more thorough manner in which young persons aiming at commercial pursuits are instructed on the Continent, while England is quoted as an example to be followed of the higher education of women. It is satisfactory to find, in this report also, that the province of Ontario, in Canada, stands at the head of educating countries. There a system of free schools and compulsory attendance was established in 1871; and while the number of children within the school ages of five and sixteen was 492,460, there were actually attending schools 489,015! On the other hand, it is surprising to find the illiteracy of a very large proportion of the population of Prussia, where of 40,000,000 persons (including infants, etc.), 25,000,000 were unable to read or write!

The schools requisite to supply education to so widely spread a population as that of America are far more numerous than in our crowded country. Naturally, therefore, it is a great difficulty to find sufficient teachers properly educated and qualified for this important work. It might seem, at first, that, in a country where, on an average, each individual is better educated than in England, there would be no lack of able teachers; but teaching is an art requiring a technical education as much as any other art; and the work of those who have not had this technical training is as clumsy as most amateur work is, and is found to have the fault of superficiality. The Bureau of Education is simply an office of information and reference; it has no central control over the various States; and one result of this is, that no uniform standard of capacity is required of those who present themselves as teachers, and two standards are to be found, not only in the same State, but in the same city. A more unsatisfactory difficulty still is the favoritism and even corruption, not unfrequent in appointing and dismissing teachers, who, in many cases, seem to go in and out of office like the nominees of a government. The picture of corruption on page 22 must surely be an extreme case; but its possibility must add greatly to the difficulty of the situation. Pennsylvania's is called a proud record, there dishonesty among school-board officials is *almost* unknown; "a few thousand dollars would cover all the losses." These things tell greatly against the business of a teacher being an attractive one, and, to add to them, in many States, as in Virginia, diminished public funds have been allotted to the common schools; the number of schools has been reduced, and the salaries of the remaining teachers lowered. In some countries in that State the local boards determined to open no schools, and to use the income for paying off debts.

The small pay of teachers, in the lowest standards especially, leads them to throw up that branch on the first opportunity—a very mischievous thing in its results—for in nothing is it more true than in the case of education that what is well begun is half done. Hence a good infant school is an immense help to all subsequent stages, and *vice versa*. So much is this deterioration felt in Michigan, where salaries of schoolmistresses have been reduced to the level of those of domestic servants, that the attendance at the primary schools has absolutely fallen off; and the explanation of it seems to be that these faults are well known to the intelligent public of the United States, and accordingly the children are being removed to private schools. The Commissioner very aptly quotes Roger Ascham's words:

"It is a pity that commonly more care is had, yea, and that among very wise men, to find out rather a cunning man for their horse, than a cunning man for their children. . . . To one they will gladly give a stipend of 200 crowns by the year, and loath to offer to the other 200 shillings. God that sitteth in heaven laugheth their choice to scorn, and rewardeth their liberality as it should. For he suffereth them to have tame and well-ordered horses, but wild and unfortunate children; and therefore, in the end, they find more pleasure in their horse than comfort in their children."

This is not a bright picture of the work of education in America. It certainly seems an indication that our brethren there are losing faith in the old rule, that what is worth doing at all is worth doing well, but it does not go very deep below the surface of so vast a work. On the whole there continues a steady rise in numbers of both schools and pupils, though not so large since 1875 as we should have expected in such a progressive country. This rise also is almost wholly in cities, again pointing to the difficulty of supplying the *number* of schools required in so wide-spread a country. In one of the most flourishing of these cities also, Chicago, it sounds more like the Old World to read that more than 2,000 children are taught in underground rooms, where the light is so bad as to expose their eyes to

* United States Report of the Commissioner of Education for the year 1879. (Washington Government Printing Office, 1881.)

serious injury! In New York and New Jersey, where population in its extremes of rich and poor keeps crowding together as in older countries, the school attendance is actually falling off. In Maine, New Hampshire, and Rhode Island the population is, curiously enough, at the present time decreasing, but school attendance is increasing; not quite one-third of the population attend daily; nearly two-thirds are on the books. In nearly all Southern States there is considerably increased attendance. The administration of the Peabody Fund has had a remarkable influence in developing the school spirit in the South, in awakening the people to a sense of their obligation with reference to the support of public schools and in maintaining a high standard for such schools. This last result has been accomplished by the wise policy pursued by Dr. Sears in insisting upon a certain degree of excellence in a school as the condition of receiving aid from the fund.

An increase of more than fifty per cent. in the number of students in the schools of science in 1878 led to the number of these schools being raised from 809 to 884; but this increase of pupils hardly kept up in 1879. Still science, though a long way behind theology in number of schools, is rapidly gaining ground upon it, and has already far outstripped it in number of students. In 1870 there were 80 schools of theology, with 3,254 pupils, which numbers have grown respectively to 133 and 4,738; the corresponding numbers for science are 17, increasing to 81, and 1,413, increasing to 10,914! This has called for a large increase of teachers; and, accordingly, while in secondary schools the proportion of those receiving a scientific to those receiving a classical education is as two to five, in the preparatory department of colleges the proportion is as four to five. At some of these colleges there are workshops, where the use of tools is taught to students by their being used in the production of other tools and things useful to the establishment. The Massachusetts Institute of Technology has one of these workshops upon a plan designed at the Imperial Technical School of Moscow, Russia. The income of these scientific colleges is partly derived from the sale of lands allotted to them in each state; £30 a year is charged to each pupil for tuition, but it represents but a small percentage of the income. The Cooper Union Free Night Schools of Science are well described as "an intelligent application of a great charity." Their purpose is the technical instruction of the laboring classes, and the means used are a free library and reading-room, free lectures, and two classes of schools, viz., the Evening School of Science and Art, and the Art School for Women. All money earned in the schools belongs to the pupil, and a number are thus enabled to support themselves while studying. A Telegraph Company has appointed a teacher in this school, who trains the pupils in their methods of working their instruments, and they have employed many of its graduates on their lines. Still the report indorses the doctrine that even in technical schools, principles, not practice, must be the leading object of a school, and that even to those following a special business, a broad general culture is very important, and a want of it very much felt. After reviewing the various schools and institutions of this class in the United States, the Commissioner of Education is led to the conclusion that "the present condition of scientific and technical schools in our country is thus seen to be very promising. . . . Already they have excited the people to an appreciation of scientific methods and processes in their application to agriculture and the mechanic arts; and as the results of such methods are more widely known and more fully comprehended, the institutions rise in favor and influence, and the demand for their graduates increases."

Drawing is highly eulogized, and its importance insisted upon. In Massachusetts any town *may*, and every city and town having more than 10,000 inhabitants *shall*, provide for instruction therein; and a training school for teachers has been organized to meet their wants, with the result also of supplying designers to manufacturers who were in want of them.

On the law schools in America, our report observes that it is surprising that a profession which requires such thorough preparation, and which has in it so large a number of men of wealth, and one which occupies so important a place in the public affairs of the country, has done so little to endow its schools in the most substantial manner.

Medical men are very plentiful in the United States compared with other countries; 1 to every 600 inhabitants, while Canada has only 1 to 1,200 inhabitants, Great Britain 1 to 1,672, Germany 1 to 3,000. A higher standard of examination is recommended, and an all-round education insisted upon Only five schools at present require the highest amount of study to qualify a full practitioner.

A valuable branch of education is the training schools for nurses, which adopt a very high standard as to whom they receive for their important functions. A small sum, however, is *paid* to students, besides board and lodging, the latter of which is carefully provided them at a bright cheerful home away from the hospitals where their duties are inculcated.

More than 30,000 blind people are among the population of the United States, and their education is considered, like other education, a duty and not a charity, and is provided out of national funds. Again, the education of the feeble-minded is systematically provided for, as being necessary for the prevention of crime, and useful to individuals of all classes. This leads on to the most important question in a country where population is thickening even as much as in America, of Reform Schools. There, under the Michigan system especially, which all should investigate, it seems fully realized that prevention is better than cure; and that while these industrial homes are indubitably powerful in preventing the formation of criminals, prisons, on the other hand, are just as indubitably powerful in carrying it on!

Evening high schools have been worked in several American cities, but hardly with results lending much encouragement to increase. One would think, however, that the knowledge gained at elementary schools by the age of fourteen would lead to a wish for more on the part of many, to whom a library only could not supply it. But free libraries are a great power in the United States. Forty-nine new ones were opened in 1879, containing 86,779 volumes, making a total of 3,842 public libraries of all classes. The correspondence with the Bureau of Education on the subject of public libraries far exceeds that on any other subject; academies standing next, and art and science standing curiously low for a country like America. Yet local feeling varies even on a favorite subject like free libraries, the large manufacturing town of Paterson being without one like so many populous English towns.

Like free libraries also, agricultural education is a department in which England, notwithstanding the height to which husbandry has been brought there, stands lower than in any other country.

One can hardly, nevertheless, read this report without feeling that spite of our shortcomings the advantages are not all on the side of America. Our compactness, plentiful supply of thoroughly-trained teachers, and, we must add, higher sense of honor in political transactions, perhaps owing in part also to the close inspection to which the works of every man are subjected here, entitle us to feel how far better we are placed, as far as meeting educational requirements goes, than the thin and scattered families of the United States.—*Nature.*

THOUGHTS ON CHEMICAL AFFINITY.

By CHARLES MORRIS.

THE whole science of chemistry consists in the investigation of the attributes and combining properties of the molecules of matter. It begins with an investigation of the differences and relationships of the bases of the several elements—the so-called chemical atoms. It follows with a like investigation of the various compounds of these elements, and of the peculiarities of attraction which they display. Their physical properties, their electrical behavior, etc., are included in the above summary.

But when we come to ask, What are the properties of elementary and compound substances? we are apt to receive a much too diffuse answer. Their colors, tastes, shapes, and their physical effects upon the human system are given as distinguishing properties. These characteristics are, of course, important as aids to the recognition of substances, yet they express only their physiological effects; their action upon light, and through it upon our senses; or the results of their direct contact with the body.

But if we consider only the immediate relations of the elements with each other, these external characteristics, which apply to them principally as masses disappear. There remain only their affinities, their specific gravities, and their thermal and electrical relations. It is to their affinities we wish here to particularly refer. The minute particles of elementary matter attract each other with a vigor which differs with every change of substance, being powerful in some cases, and weak or non-existent in others. And this attraction is more powerful between elementary atoms than between compound molecules. If chemistry be rigidly separated from other sciences, the above phrases almost completely embrace it.

But what are the true characteristics of the attractions which thus tend to combine chemical atoms and molecules into more complex molecules? Or we might first ask, What are the characteristics of attraction? It has, as we know, one general form, that of gravitation, which affects all matter alike, without discrimination. It has, also, one special form, that of magnetism, which affects all compounds of matter, but which specially discriminates. In its general form of gravitation I have argued in a preceding paper that the attractions of matter are balanced by their repulsions, but that the attractive matter has everywhere gathered into globes and systems, so that repulsive vigor, in its general aspects, now only exists between widely separated masses of matter. In its special form of magnetism the attractions are visibly balanced by the repulsions, these conditions occurring together in every mass of matter. Beyond these two modes of attraction there is no positive evidence that any other exists; for electric attraction may possibly be a special display of magnetic energy, while physical cohesion and adhesion resemble gravity in their characteristics. There remains but chemical attraction, and we may reasonably ask, Is this a special mode of attraction, or is it a manifestation of gravitative or of magnetic energy? It cannot be a result of gravity, since it discriminates in its action. It therefore must be magnetic, or else a special mode of attraction.

As to which of these explanations should be adopted, we have a useful rule of guidance. If it were impossible to explain chemism by any known mode of energy, then there would be some warrant for ascribing it to our unknown mode. But if it can be shown to be explainable by a known mode, this obviates the necessity of seeking any unknown mode; since it is undeniable that whatever tends to simplify and reduce the seeming complexity of natural principles is in the true path of correct discovery. Let us try, then, if we can apply the laws of magnetic energy to the phenomena of chemical affinity.

The ordinary display of magnetism is an influence emanating from molecules which are separated by considerable intervals, and whose magnetic effect upon each other is, therefore, much decreased. But in chemical action the spaces separating the molecules are greatly reduced. The heat energy which kept them asunder is yielded outwardly, and they come into intimate union. They are then in a position to develop each other's magnetism. In the former case they resembled two magnets so far separated as only slightly to affect each other. In the latter case they resemble two magnets which are made to touch each other.

But magnets may touch in different modes, and thus produce various combinations. If brought together end to end, they attract if their adjacent poles are unlike, and thus compose a single long magnet. There is no doubling of energy in this double magnet. It attracts no more strongly than did each of its constituents. If the magnets are brought together side by side, with unlike poles in conjunction, they will also attract, but the magnetism of each will mask that of the other, and thus there will be no external display of magnetic energy. If brought together, in either of the above positions, with like poles adjacent, they will mutually repel.

If, instead of two, three or more magnets be employed, their possible modes of combination will increase in variety. The effective energy of a strong magnet may be decreased by astatic union with weaker magnets. Also the poles of a strong magnet might attract several weaker magnets, whose free poles, being of the same name, would mutually repel.

If, now, chemical affinity really arise from the attractive relations of molecular magnets, brought very close together, it should display peculiarities like those seen in the combinations of mass magnets. But it might also display characteristics not usually seen in the mutual action of mass magnets. The facility of rotation of the molecules would tend to make them usually assume the strongest magnetic relation, that of astatic union; they might, if in considerable number, unite in all the various modes in which a collection of magnets would come together, but when only two molecules were concerned their combination would most probably be astatic.

This idea is very significant if we apply it to one of the primary chemical actions. It is now generally believed that the chemical atoms never, or only in exceptional cases, exist singly, but that they are ordinarily combined in pairs. And it is also found that when single, as when just released from combination with some other element, their chemical vigor is far stronger than after they have had time to combine among themselves, and form atomic pairs. Such a result would necessarily follow if their attractions were magnetic. In the free or nascent state, their magnetic attraction must be far more vigorous than after they have formed astatic pairs with each other, and thus have become magnetically inert. In a case like that of ozone, where three chemical atoms of equal strength are conjoined, we would have a weak magnetic system, since each magnet must disturb the attraction of the other two. One of these oxygen atoms might thus readily yield to outer attractions, and the two remaining enter into a more vigorous union. But four atoms, as in the molecules of phosphorus and arsenic, might naturally conjoin in a square or circle, each being astatic to its two neighbors. Any even number of atoms must produce a more vigorous astatic arrangement than an odd number.

Another peculiar feature of chemical affinity, that of the possession of varied bonds of affinity by varied elements, may perhaps be equally explicable on the magnetic hypothesis. It might be that the monad has only one-half the magnetic energy of the dyad, one-third that of the triad, and so on; and that, therefore, it would require two monads to satisfy the magnetic energy of one dyad, etc. This could scarcely be were all the chemical elements prime molecules of matter. The magnetic energy of these could scarcely possess such exact numerical relations. But if the chemical elements be really, in great part, more or less complex compounds of these prime molecules—if there be but one, or but few, kinds of prime molecules, from whose simpler combinations the chemical elements arise, then the free energies of the latter would necessarily be in strict numerical proportion. They would comprise sums of equal magnetic units, some of these being masked by their astatic combination, others directed outwardly, and the element would display as many bonds of attraction as it had units of magnetic energy directed outwardly.

There is another chemical condition to which we must here refer. This is, that the quantivalence of an element is not at all times the same, and that, when it varies, it loses or gains two, or a multiple of two bonds, never—with a few possible exceptions—one or three bonds. This fact is explained in ordinary chemical language by saying that the free bonds satisfy each other, and that, therefore, they must be in even numbers. But there is no explanation as to how they satisfy each other.

This mystery ceases to be one under our magnetic hypothesis. The free bonds are simply free magnetic poles, and they may be satisfied by magnetic reversal and astatic union in any two of the polar molecules. If, for instance, the five bonds of an acting molecule consist each of a magnetic unit, then one, two, three, four, or the whole of these, may attract monad atoms. But if four bonds be thus employed, the fifth cannot become masked; it can only satisfy its attractions outwardly. If three only be employed, the remaining two may satisfy each other's attractions. Inductive action between them may cause a reversal of poles in one or the other, and they thus become astatically combined. The case is similar to that which is known to occur when a number of magnetic needles are bound together to form a compound magnet. The poles of some of them become reversed by induction. Every one so reversed must mask the magnetism of one not reversed. Thus the bonds of attraction of the compound magnet are reduced by twos with every reversal. If the magnetism of half the needles were reversed, the compound magnet would become inert. Each of its poles would have an equal north and south polar energy.

But if, in any such case, a vigorous magnetic energy be brought to bear upon the compound from without, it is not impossible that it might overpower this local influence, and reproduce the original arrangement of the poles. Thus, in the molecule of five bonds, the two masked ones might assume their former conditions, and again display outward attraction.

The graphic formulæ now given in works on chemistry plainly show the application of this magnetic hypothesis to chemical compounds. If, in a complex organic compound, we consider each C, O, H, N, etc., of its formula, as written out graphically, to be a magnet, with a definite attractive vigor of one, two, three, or more units, and that part of these bonds are attached by attraction to equal bonds of other elements, while part satisfy themselves by astatic combination, the formula seems to assume a new phase, and much of the mystery which has enveloped it to yield to the test of this new way of regarding it.

Of course the hypothesis, as so far outlined, does not explain the mysteries of elective affinity. We might reasonably assume that combinations of magnets could be in no sense elective in their attractions, and that every two molecules, of whatever character, possessed of free magnetic energy would tend to combine. Of course, in the great variety of modes in which magnets might possibly combine, there might be considerable differences in attractive vigor, the magnetic energy of some being employed inwardly, and that of others largely directed outwardly. There might also be great differences in responsiveness to induction, through the different degrees of centripetal magnetic energy. But aside from the phenomena of chemical inertness or activity arising from these causes, there are peculiarities of affinity which need some other explanation.

Elective affinity has some close connection with the electrical behavior of the elements. As a rule, the most vigorous affinities exist between elements furthest apart in the electrical series, while compounds of these elements display affinities which diminish in vigor as they approach the neutral region between the electrical extremes. It remains true, however, that there are many instances of special affinity which have no definite relation to electrical behavior.

In static electric attraction and repulsion, it is very possible that the electric condition affects the magnetism of molecules. That electric excitement is an affection of molecules, is undoubted, and that it produces heterogeneous conditions in each molecule, yielding the phenomena of electric polarity, is equally evident. If, then, the two halves or the opposite extremities, of the molecule are put into diverse states of energy by the inductive action of electricity, it is very possible that their magnetic condition may be affected by the same cause. The electric excitement seems to weaken the chemical cohesion of the constituents of molecules, and to cause them to exert a more vigorous outward attraction. But if this chemical cohesion be an effect of magnetic energy, then we might say that the centripetal magnetic energy of a molecule is decreased by electrical excitement, and its centrifugal magnetic energy increased. The electrical induction is an effect of exterior forces, and these may also produce a magnetic induction, weakening the astatic self satisfaction of

molecules, and causing them to seek exterior satisfaction of their energies.

Certainly it is far more likely that the attractions and repulsions of electrized bodies spring from the magnetism which we know to exist in these bodies than that they arise from some unknown attractive condition of matter. That the intimate action of electricity upon molecules might produce effects upon their magnetism, far superior to anything which human experiments with magnets can perform, is very evident; and it is not at all surprising that substances inert to ordinary magnetic influence should display exterior magnetic energy, when their most interior energies are separated, accumulated at the molecular poles, and their forces directed outwardly.

The character of the attractions and repulsions of electricity is also closely accordant with that of magnetism. Electricities of the same name always repel, while those of opposite name always attract. But we might otherwise express this by saying that electricity converts the molecule into an active magnet, with its one pole always turned to the positive, its other pole to the negative extremity. Suppose, for illustration, that north magnetic polarity were always associated with positive, and south with negative electricity. Then the peculiarities of attraction and repulsion perceived would necessarily arise. A mass affected with induced electricity would resemble a magnet, with its north pole turned to the positive, its south to the negative end. A mass with positive electric charge would form a collection of molecular magnets, each with its north pole directed outwardly, its south inwardly. The magnetic inharmony thus produced would be the result of the electrical inharmony. Nor need this induced magnetism produce stronger relations with the magnetic needle than with other conductive matter. The mass with induced electricity displays the true magnetic attributes, but only toward electrically disturbed substances. The normal magnetism of the needle has no electrifying influence, and conversely is not affected by the results of electric influence.

There is another feature of elective affinity which needs consideration—a certain arbitrariness which must arise from some special cause. And this arbitrary character of chemical attraction may be due to the cause to which we formerly attributed the electrical excitement, namely, to the diversity in the vibratory pitch of molecules. It is exceedingly probable that these divergencies in pitch of vibration hinder the tendencies of molecules to combine, and that no stable combination can be produced unless these discords are overcome, and are modified into harmonies. Two molecules vibrating at closely accordant rates might readily conjoin. Two less accordant in their vibrations must oppose a certain resistance to conjunction. Two completely discordant might utterly refuse to join, they being unable to form a stable combination.

That such variations in vibratory pitch must exist is unquestionable. And that two atoms or molecules vibrating at discordant periods—in which they might persist to some extent, despite their mutual influence—could not form a stable combination is equally unquestionable. Although in all such cases magnetic affinity might seek to produce combination, without regard to the special characters of the molecules, this general tendency to combine would be opposed by the special resistance to combination offered by these diverse movements. Two molecules swinging together in unison would support and sustain each other's attractions. Two which constantly darted apart from each other could never form a close union, and would be constantly exposed to exterior energies.

It needs special conditions of isolation from disturbing influences to bring elements of feeble affinity into combination with each other. Such conditions are produced in organic nature, and thus complex molecules are built up whose constituents must display considerable diversities of vibratory pitch. The more intricate these compounds the less coherent are they. Their combinations are only safe while protected from external influences of a stronger character. When exposed, for instance, to oxygen, this element of vigorous affinity disturbs the incoherent union of diverse elements. The varied vibratory swings of the latter hinder them from coming into close and dense union. A certain space must be necessary for feebly accordant movements to take place in, and these intricate compounds, therefore, form molecules of slight density, verging from the solid, through the colloid, toward the liquid. Oxygen seizes, as circumstances favor it, on one after another of the outward swinging atoms or molecules of these compounds, and forms with them molecules of more harmonious motion and intimate elemental relations, so as in time to quite break down the large but feebly accordant compound of vibrating molecules.—*Journal of Science.*

SELWIG AND LANGE'S IMPROVED OSMOGENE.

THE osmotic clarification of juices, discovered and applied by Dubrunfaut in 1863, has rendered very great services in the sugar industry. The Germans have made an application of this wonderful discovery and drawn great profit therefrom. Osmose is met with in all sugar works, in all refineries, and the apparatus, which are large in number, permit of dialyzing several times in order to extract all the sugar from the molasses. In this way a yield of 10 per cent. of sugar is reached per 100 kilogrammes of beets.

Osmotic clarification is based upon the property possessed by animal membranes and vegetable parchment of separating the salts of sugar contained in molasses or sirups.

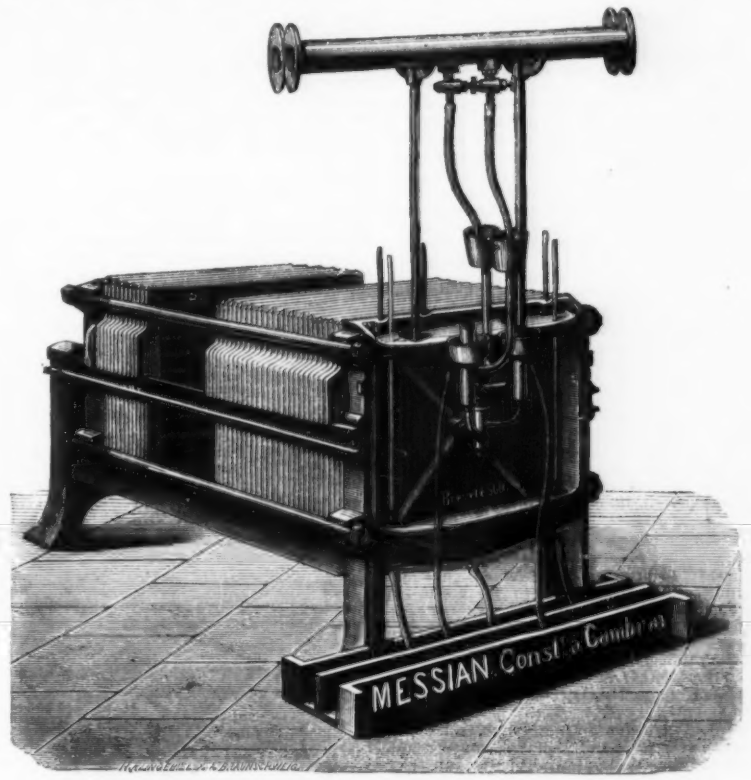
With one square meter of paper there may be eliminated per hour 1·5 kilogrammes of salts prejudicial to crystallization, when the operation is performed on hot molasses of 85° to 90°, and with pure and hot water of 90° to 95°. In manufacturing, such a result may be obtained on condition that the currents of water and molasses are regular, and that the points of contact with the paper are constantly renewed. The majority of osmogenes are far from giving such results.

In the improved osmogenes of Selwig and Lange, however, the apparatus is so arranged that a regular distribution of the water and molasses is obtained by causing in each frame a mathematically uniform and equal suction. The surfaces of contact are continuously renewed, all the frames and all parts of the paper operate equally, and there is thus obtained a maximum of effective work with a minimum of wear in the parchment paper.

This remarkable result is obtained by means of two so-called "retrograde conduits," placed, one above and the other below, on the right hand side of the apparatus, and parallel with the conduits that are usually found in all osmogenes serving for water and molasses.

These retrograde conduits, like all other conduits, consist of holes pierced in the thickness of the frames, but they are not provided with communicating apertures that open into the frames.

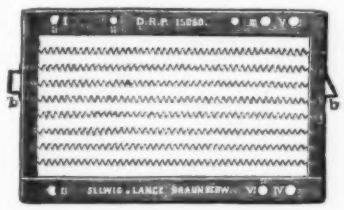
Each frame is provided with vertical wooden rods of elliptical section pierced with many communicating apertures along their length, and hollowed out at the lower part to facilitate cleaning, and a flow of the deposits that might form there. This new arrangement, which does away with cords, and insures of a uniform circulation in each frame, needs a few words of explanation. In the old osmogenes now in use the sheets of paper are held by cords, and the horizontal rods that Dubrunfaut recommended are no



SELWIG & LANGE'S IMPROVED OSMOGENE.

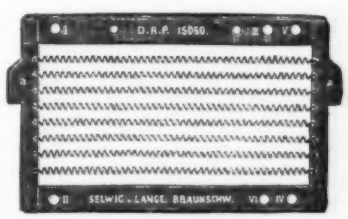
larger met with. The result is that the liquids pass directly from the entrance to the exit of the frames, and that a current is set up in a diagonal direction without going to the other points. The different parts of each sheet do not, then, operate equally; and this is a very grave inconvenience, and explains the small result obtained with the old style of osmogenes.

The vertical wooden rods, which were employed at first in the former Selwig and Lange osmogenes, were an improvement over the cords commonly used in such apparatus in general, but the substitution for these of brass spiral springs constitutes still another progress which, among other advantages, possesses the one that it does away with all necessity



of keeping the frames in repair as long as these last. In fact, wooden rods are apt, through the effect of heat, to warp, to elongate, and thus to tear the parchment papers. Cords are still less durable, and the papers are not so well held by them, and the result is a more rapid deterioration of the papers. Besides, there is the labor of replacing the cords—an inconvenience that endeavors have been made to overcome ever since osmogenes have been known.

With metallic rods or spiral springs of brass all the inconveniences that we have noted disappear. The papers are well supported on each of their surfaces, because the springs of two consecutive frames are not parallel, but cross



each other, and possess also the requisite tension to keep the papers in place while at the same time they yield sufficiently to the very slight currents produced by the entrance into the apparatus of liquids of different densities. As, in addition, these springs are made of brass of small diameter (1½ mm. at the most) they occupy but very little space in the frame, and the quantity of liquid which may be introduced into the latter is thus considerably increased. The result is that the delivery of a Selwig apparatus (which, on account of the rational circulation of water and molasses was superior, even when wooden rods were used, to that of analogous apparatus) amounts (the number of frames being the same) to about 15 per cent. more than that of any other osmogene known. This fact has been ascertained in different comparative trials.

The cleaning of the frames is very easy of execution, and there is not to be feared, as is the case when cords or wooden rods are used, a breakage of these delicate parts by an accidental accumulation of sediment at the bottom of the frame. This modification in the mode of supporting the parchment papers is already gaining the approbation of even those manufacturers who are using the old style of osmogenes.

The number of frames employed ordinarily in this new osmogene is 51, but the manufacturer, Mr. Messian Lengrand, is also making sizes that hold 100, thus materially decreasing the expenses of the first installation.

CHEMICAL WORK PRODUCED BY THE BATTERY.

By D. TOMMASI.

JOULE & FAVRE have shown that the power of the galvanic battery is intimately related with the heat produced by the chemical reactions in the battery itself, and that an entire order of questions relative to currents may be treated like problems in calorimetry. Thus the electromotive force of a battery would be proportionate to the heat liberated by the chemical action, and consequently knowing the calories liberated by this chemical action we may find the work which the battery is capable of producing. Favre has shown, however, that the heat brought into play during the combustion of the hydrogen in electrolysis is transmissible or not transmissible to the circuit according to the nature of the compound which furnishes the oxygen necessary for the combustion. Thus, of 131 cals. disengaged by a couple with oxygenated water and hydrochloric acid, there would be merely 41·6 cals. transmissible to the circuit, and representing consequently the energy of the battery. Favre has further observed that in the sulphatation of the zinc of a simple couple (zinc, platinum, and acidulated water), 39 cals. are brought into play, but that of this number only 29·8 cals. are transmissible to the circuit, whilst 9 cals. are confined to the interior of the battery. A zinc-platinum element with dilute sulphuric acid (Smee's) should disengage, according to Favre, 39 cals., but of this number only 29·8 would be transmitted to the circuit, and represent the energy of the battery. Two such elements, therefore, ought not to decompose water. 29·8 cals. + 29·8 cals. < 69 cals. But the author has found that the decomposition takes place as if all the calories disengaged by the two elements had been transmitted to the circuit. 39 cals. + 39 cals. > 69 cals. (Favre), or, calculated according to thermic data, 38 cals. + 38+1·4 cals. > 69 cals. If the water of the voltameter is acidulated with hydrochloric acid the decomposition of the water takes place more easily. But even in this case there ought to be no electrolysis, since, according to Favre, 29·8 cals. + 29·8 cals. < 66 cals. If we substitute in the above elements for the two platinum plates two graphites, previously heated to redness—which, according to received ideas, should not in any way modify the chemical action of the battery—the decomposition is produced very briskly. If we employ in the battery electrodes of coke with a large surface, the decomposition of the water is much more energetic. According to Favre two zinc-platinum elements in dilute hydrochloric acid ought not to decompose water if it is acidulated with sulphuric acid, but should decompose it if acidulated with hydrochloric acid. Two zinc graphite or zinc-coke elements decompose water acidulated with sulphuric acid. This decomposition cannot be explained according to Favre, but it is intelligible according to thermic data: 34·2 cals. + 34·2 cals. + 1 cal. > 69 cals. A zinc-platinum element in dilute hydrobromic acid ought, according to Favre, to liberate 35·9 cals., but only 29·9 cals. would be transmitted to the circuit. Two of these elements therefore, ought not to decompose water acidified either with sulphuric or hydrochloric acid, for in the former case 29·9 cals. + 29·9 cals. < 69 cals., and in the second 29·9 cals. + 29·9 cals. < 66 cals. If the water of the voltameter is acidulated with sulphuric acid decomposition sets in, but ceases soon. The decomposition of the water is more marked with two zinc coke elements. If the water of the voltameter is acidulated with hydrochloric acid, the decomposition takes place more easily. If the

water of the voltameter is acidified with hydrobromic acid, there is also electrolysis, but in this case it is not the water which is decomposed, but the hydrobromic acid itself. However this acid is diluted, gas always escapes at the negative electrode, but at the positive electrode there is no escape of gas, but there appears around the platinum wire a yellow thread of bromine. This fact is easily explained, since 2 mols. hydrobromic acid absorb 59 cals. for decomposition, whilst 1 mol water absorbs 69 cals., and as the author has shown in 1879, the compound which absorbs the least calories is always decomposed in preference by the current.

FELDSPAR.

Of this important mineral there are the following species: Adularia, common feldspar, compact feldspar, continuous feldspar, and Labrador feldspar.

The color of adularia is yellowish, greenish, or milk white, and in certain directions it exhibits a play of silvery and pearly colors, owing to the different reflections of light from the laminæ of which it is composed. It occurs either in mass or crystallized. Its primitive figure is an irregular oblique angled parallelopiped, of which the faces in two directions are smooth and well defined, and form an angle with each other of 90°, while the faces in the other direction are uneven. The surface of the crystals is smooth and often striated longitudinally. They are for the most part middle sized or large. The external luster is shining and somewhat pearly; the luster of the principal fracture is bright shining, between vitreous and pearly. It breaks into rhomboidal fragments. It is translucent, passing into transparent. Its hardness is inferior to quartz, but greater than that of common feldspar. It is easily frangible. The specific gravity is 2·5 to 2·6. When exposed to the blow-pipe without addition it crackles a little, and at length melts into a whitish glass. It has been analyzed by Chenevix with the following results: Silex, 64; alumina, 24; lime, 6·25; oxide of iron, 2; water, 1·75. Adularia was first found in Mont Adula, in Switzerland, whence its name. The moon-stone of Ceylon, and a mineral discovered in Languedoc by M. Dodun, and named by him *œil de poisson*, are also considered as varieties of adularia.

The color of common feldspar is milk white, yellowish, grayish and reddish white; also wax yellow and ocher yellow; flesh red, blood and brick red; leek green, mountain green, and sometimes, though rarely, verdigris green. It occurs in mass, disseminated, in rounded fragments or crystallized. Its primitive form and the other varieties of crystallization that it assumes are the same as those of adularia. It varies from translucent to opaque. It occurs often in granular concretions, either large or small. It is not so hard as quartz, yet will scratch glass; it is brittle and easily frangible. Specific gravity, 2·27 to 2·70. It melts before the blow-pipe without addition into a white, somewhat translucent, glass. Feldspar has often been analyzed and with very different results. The following analyses are from Chenevix:

	Common F.	Ceylon F.	Siberian F.
Silex	64	68·5	62·83
Alumina.....	24	20·5	17·02
Lime	6·25	7	3
Oxide of iron.....	2	1·5	1
Potash	0	0	13
	96·25	97·5	96·85

Feldspar when exposed to the weather acquires gradually an earthy appearance, and at length passes into porcelain clay. It also occurs in a state of semi-decomposition in several varieties of granite and porphyry, where it cannot have been effected by the atmosphere. When in this state it is usually of a yellowish or reddish white color, a faintly glimmering luster, and a fracture imperfectly foliated passing into earthy; it breaks into indeterminately angular fragments, is opaque, and considerably softer than common feldspar.

Some of the colored translucent varieties of feldspar contain particles of mica dispersed through their substance, and these, when the stone is exposed to the light, form so many luminous points, which relieve the color of the feldspar and give the whole a spangled appearance that has a pleasing effect. When feldspar exhibits this appearance it is called aventurine, a term also applied to a similarly glittering variety of quartz.

Common feldspar is the most generally diffused, both as to its local and geological situation, of any other mineral except perhaps quartz. It is an essential constituent of granite and gneiss, and frequently occurs in micaceous and argillaceous schistus; it forms a large proportion of all selenite, and is contained abundantly in all porphyries; it abounds in primitive, transition, and secondary grunstein, and also is found in the greater part of the real lavas.

Compact feldspar is bluish white passing into sky blue, or greenish white passing into brownish green. The blue variety occurs in mass. Its luster is glistening, it is feebly translucent, and though hard, considerably inferior in this respect to quartz. Before the blow-pipe it is difficultly fusible without addition, into a frit or imperfect glass. The blue compact feldspar was discovered by Widenmann, in Styria, forming a granitic mass with white quartz and silvery white somewhat unctuous plates.

Continuous feldspar is reddish gray, or flesh colored, or pale reddish yellow, or olive green. It occurs in mass, and generally contains hornblende or common crystallized feldspar disposed through it in various proportions. It is sometimes dull, but generally possesses a feeble, glimmering luster; it is translucent at the edges, and its hardness is fully equal to that of common feldspar, but it is less brittle. It melts at a high heat into a porous porcelain mass.

Labrador feldspar is of smoke gray or dark ash color, but on account of the small crevices between the lamellæ of which it is composed, it presents a most beautiful play of vivid tints varying according to the position in which it is viewed; of blue it exhibits all the varieties from violet to smalt blue; of green it displays the pure emerald green and various other tinges approaching to blue on one hand and yellow on the other; of yellow the usual shades are gold and lemon yellow varying into deep orange, and thence into rich copper red and tombac brown. It is strongly translucent, passing into semi-transparent. It is fusible without addition before the blow-pipe into a white enamel. It was first discovered by the Moravian missionaries on the Island of St. Paul, on the coast of Labrador, and has since been found in Norway, and near Lake Baikal, in Siberia.

It is in considerable estimation on account of its beautiful colors for ornamental purposes.—*Pottery and Glass Reporter.*

HYDROGEN DIOXIDE.

No more striking illustration could be given of the remarkable dissimilarity of substances made up of the same chemical elements in slightly different proportions than the two compounds of hydrogen and oxygen. One of these, represented by the formula H_2O, is water, the properties of which are familiar to everybody. The other, known as hydrogen dioxide, or peroxide, H_2O_2, differs in its composition from the first only in containing twice as much oxygen; but in its properties it is as unlike water as could well be imagined, while, instead of being one of the most common of substances, it is a rarity and a curiosity, except in the laboratory of the chemist. It is a colorless, oily liquid, about one half heavier than water, without smell, but with a bitter, astringent taste. Pour a little of it on your hand, and it blisters the skin, with a good deal of irritation. In contact with finely divided metals, it is decomposed with almost explosive violence into water and oxygen. One of its atoms of oxygen is, indeed, very loosely united, and is readily given up to substances that have a stronger affinity for that element. In other words, it is a powerful oxidizing agent.

This curious compound was discovered in 1818, by Thenard, who obtained it by the action of muriatic acid on barium dioxide. It is still made in much the same way, sulphuric acid being generally used in place of muriatic.

Soon after it was discovered, chemists predicted that the "oxygenized water," as it was called, would come to be of importance in the industrial arts. As early as 1830 it was used for cleaning discolored oil paintings. The discoloration arose, in most cases, from the formation of the dark sulphide of lead by the action of sulphur on the white lead in the paints; and this dark compound was changed into white sulphate of lead by the oxidizing action of the hydrogen dioxide. More recently, it has been used for bleaching the stained paper of old engravings, and for changing the color of dark hair to a golden tint; and within a few years attempts have been made to utilize it on a larger scale for the bleaching of linen and other textile fabrics.

In the primitive "grass bleaching," the chemical process is the same; that is, it is a decomposition of the coloring substances by oxidation, or the union of oxygen with the hydrogen, which is one of their essential elements. The oxygen of the air, under the influence of sunlight, is here the agent that does the work. The method is a slow and inconvenient one, and impracticable in many localities.

Chemistry has at its disposal many oxidizing agents which can be employed instead of atmospheric air, but all of them have the disadvantage of attacking and injuring the fiber to be bleached. They must be used cautiously to prevent serious mischief to the fabric, and even with the utmost care a slight sacrifice of its strength is inevitable. The hydrogen dioxide is the one agent that does not act in this way, and the only obstacle in the way of its general use for bleaching has been the difficulty of preparing it in a form suitable for use, at moderate cost. Until recently it has not been possible to obtain it on the commercial scale, except of uncertain and variable composition, and more or less charged with impurities. Now, if we may trust the reports in German industrial journals, these difficulties are overcome, and hydrogen dioxide can be got "in watery solutions of from three to ten per cent., in a uniform, chemically pure state, at low prices and in large quantities." If this is true, it must soon supersede all other means of bleaching, and add to the list of chemical compounds that, from being mere curiosities of the laboratory, have come to be familiar to the world as important industrial agencies.—*Boston Jour. of Chem.*

CORYANTHES MACRANTHA.

Is there, can there be, a more strange looking Orchid than this? A Stanhopea is singular enough in appearance, but this is even more grotesque, and yet by no means destitute of beauty—the beauty that astonishes and captivates, because strange and wildly divergent though it seems even from such out-of-the-way flowers as Orchids in general, a very little examination suffices to show that this seemingly anomalous creation has in all essentials the structure of an ordinary Orchid flower. It is strange, but the symmetry is only disguised, and it is really as normal as that of any other Orchid. In most Orchid flowers there are three sepals, three petals, one of which is modified to form the lip, and a column consisting of stamens and styles united.

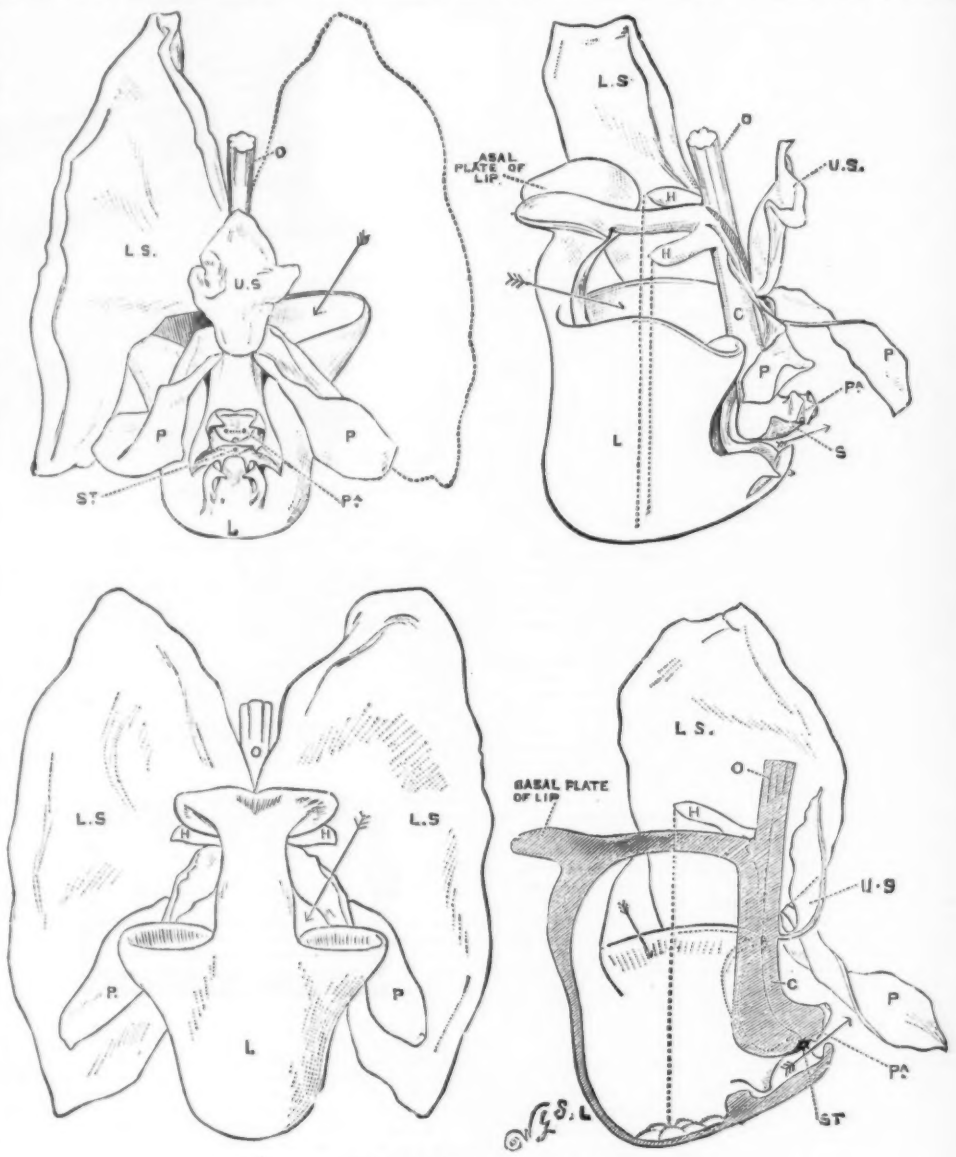


FIG. 1.—CORYANTHES MACRANTHA.

The upper flower to the left is seen from the front, that to the right from the side; the lower flower to the left has the back of its lip turned to the spectator; the figure to the right is a section through the flower.
For explanation of the letters see the text.

In this Coryanthes all the parts we have mentioned are present. In the illustrations, L S, L S represent the lateral sepals; U S, the upper sepal; P, P, the petals; L, the lip; C, the column; PA, the pollinia; ST, the stigma; O, the ovary. The circumstances which render this flower so very remarkable depend upon its pendulous direction, the central axis of the flower being at first bent downward so that the tip of the column, C, where the anther is placed, PA, instead of standing erect or somewhat horizontal, as it does in most Orchids, is bent downward. From the base of the column project on either side two horns, H H, the purport of which will be shown further on. At the same time the lip, L, presents a most extraordinary series of modifications. In the first place, as to its direction, it is bent backward, then downward, then upward, so that seen in section it resembles the letter C, or with the column, the letter O; there is in fact a cylindrical stalk stretched horizontally backward, and which expands into a thick fleshy purplish-brown plate projecting backward, called in the sketches the "basal plate of the lip;" then comes another thick stalk like process bent downward, parallel in direction to the column. This again expands below into a large bucket-shaped body, L, rounded at the back like the slipper-like lip of a Cypripedium, and which leads to the impression when it is turned toward the observer that it is the front of the flower, when

in reality it is the back. The lip is open in front to receive the end of the column, which fits closely into the aperture, and is three-lobed at the apex, the central lobe prolonged at the apex into a tooth-like process directed upward so as to come into contact with the end of the column. A reference to our figures will do more to make this structure intelligible than words can do.

Let us now see what is the meaning of this extraordinary arrangement. From the base of the column, or as it would appear, from the inverted position of the flower, from its top, project backward, as has been said, one on each side, two horns, H H, which overhang the cavity of the bucket, and distill into it drop by drop a limpid fluid, as might be seen when the plant was exhibited, and which our artist has indicated by dotted lines. Insects, such as bees, visiting the flower, alight on the thick, flat plate, and are stated by Dr. Crüger, who frequently witnessed the fact in the West Indies, to gnaw its fleshy substance and the interior lining of the labellum for food. Such attraction has this for them that they may be seen disputing with each other for a place on the plate and its vicinity, and in the contest some of them are pretty sure to be pushed off and fall into the bucket in the direction shown by the arrow *x*. To extricate themselves from their bath, the insects must crawl up along the anterior side of the bucket, *z*, so as to reach the orifice left between the upturned tip of the lip and the downturned apex of the column, as shown by the direction of the arrows in the cuts, and especially in the section shown at Fig. 1, at the lower right hand side. At the apex of the column—which it will be seen is bent a little horizontally as well as downward—is the anther with its pollen-masses, PA, so that when the half-drowned bee struggles through the aperture formed by the tip of the lip, L, and the tip of the column, C, it inevitably removes the pollen, PA, from the anther, the pollen remaining affixed to its back. Then the insect, undeterred by its prior immersion, visits the same or another flower, goes through the same performances as before, and in its struggles to escape now deposits the pollen upon the stigma, ST. Dr. Crüger tells us he has "often seen this, and that sometimes there are so many of these humble bees assembled that there is a continual procession of them through the passage specified." The liquid distilled into the bucket is, it appears, so slightly sweet, that it does not deserve to be called nectar, and does not itself serve to attract the insects. The attraction for insects is the fleshy plate of the lip, which the insects gnaw. The purport of the fluid secreted in such large quantities in the bucket is to wet the wings of the insects and prevent them from flying away, as they might otherwise do, were the bucket dry and empty. The attraction for the bees in the first instance resides in the smell of the flower, the same insects visiting Coryanthes maculata, Stanhopea grandiflora, and Gloxinia maculata, all three of which have the same perfume. Such is the story narrated by Dr. Crüger and Mr. Darwin, and although in our hothouses it may never fall to our lot to see the whole process, yet the construction of the flower, as any one may see who will read the account and compare it with Mr. Worthington Smith's accurate illustrations, quite bears out the wonderful history just given.

The plant from which our figures were taken was exhibited before the committees of the Royal Horticultural Society at one of its recent meetings by Sir Trevor Lawrence, who kindly placed at our disposal the flower from which the accompanying illustrations were made. It is difficult to overestimate the keen interest a flower like this excites in the mind of a naturalist. He is as much struck with the weird beauty and strange appearance of the flower as his fellows, and he has the intense pleasure of seeking and of finding the explanation of all these remarkable modifications, and of admiring the marvelous adaptations to purpose and design which they show, and yet, when the key is found, all this apparent strangeness of form and disposition is seen to resolve itself into the ordinary Orchid-type of construction.—*The Gardeners' Chronicle.*

FIG. 2.—CORYANTHES MACRANTHA.

The central flower has its back turned to the spectator.

ON PLANT DRYING.*

By LEO. H. GRINDON.

WE are now in the heart of the season when it is useful to give a little time to the preservation of plants for the herbarium. Collections of dried specimens of course are not to be regarded as anything more than means to an end. It is not accumulating a vast quantity of vegetable mummies that makes a botanist, however elaborately they may be arranged, however pretty their epitaphs. Botany is the study of plants as they live and grow, their manner and customs, their curious ways and changes, noting these carefully, and then in order that the memory may be assisted at times when living examples are unfavorable, drying one or two good examples in the best possible manner, sorting and labeling them, so that the whole constitute a kind of dictionary. This is the true and essential idea of an herbarium or Hortus Siccus, the only one that is to be approved, the only one that carries with it the ideas of common sense and of really practical results for good to the collector. When the work of our hands can be supplemented with gifts from friends, and particularly from friends residing in foreign countries, so much the better. But it must never be forgotten that no one can ever claim exact knowledge of a plant who has merely seen it dead.

The very ancient adage, that if a thing be worth doing at all it is worth doing well, applies to the preservation of plants for the herbarium as much as to any great and important work or business. Specimens that are no better than fragments of brown stick, or that seem effigies of plants cut out of thin brown paper, the flowers shriveled and shrunk so as to be no longer intelligible, the leaves crumpled and doubled up, everywhere confused and mashed together, such as one may see sometimes in collections, are altogether undeserving of the name. Nothing that is not dried in the best manner possible, its colors and configuration preserved as perfectly as the nature of the plant will admit—ought ever to be allowed a permanent place in the herbarium. The bad may be tolerated awhile, in default of better, but the further a specimen is from vivid and pleasing resemblance to the living thing, the speedier should be the endeavor to supersede it. Specimens from abroad that cannot be superseded of course we do not speak of. It is of plants within reach that none but admirable representatives of their best features while alive should be considered worthy of a place. Plants dry very variously. Some require not a moment's trouble, others demand patience. Now and then the case is hopeless, and we are constrained to fall back upon the pencil, and prefer drawings, colored ones if possible. Grasses and their allies, most kinds of ferns, plants that resemble heather, "everlastings," the mature leaves of shrubs and trees, call for only the minimum. Those which try the patience, and can be managed only after considerable experience with easy ones, are such as may be illustrated by citation of the hyacinth. To secure the best results, obtain first half a dozen pieces of stout millboard, cut to about eighteen inches by twelve. Then gather together a hundred old newspapers, and fold them neat and square to about the dimensions of the millboards. Four or five yards of common white cotton wadding, a score of sheets of tissue paper, and as many of blotting paper, all cut to the same size, complete the apparatus. One of the boards serves for the foundation; on this lay a newspaper, then a piece of wadding, and upon this place the specimen intended to be dried. The cotton being soft and retentive, every portion can be laid in a proper and natural way, including the petals of the flowers. A newspaper above, two or three if the specimens have thick stems, and so on till all shall be deposited in the way of the first. If the specimens are sticky or hairy or of a kind that the wadding seems likely to adhere to, then before depositing them on it, introduce a half sheet of the tissue paper. A heavy weight must be put on the top of all sufficient to embed the specimens in the wadding; then leave the whole to rest for twenty-four hours. All the papers must then be changed, dry ones being put in their place; and if the plant seems to throw off a very considerable amount of moisture, such as will render the wadding quite damp, change the wadding also. A second and even a third change is desirable at the end of two or three days or a week, and when this is made introduce the blotting paper, pressing again till everything is perfectly flat and the specimens are absolutely dry.

Such is the simple process by which the writer of these lines has succeeded in the art of preserving the colors and forms, not only of robust and tractable plants, but of the most delicate and very many of the obdurate. Every petal, every leaflet retains the form it had in life, and nine specimens out of ten keep their colors excellently. To insure the keeping of *color*, it is well if time can be spared to change the blotting paper many times and to dry it thoroughly before the fire, but this need not be done till after the third day from the beginning.

Most curious are the phenomena now to be witnessed. If those pertaining to the history of life are full of interest, those which accompany death almost equally arrest attention. The grand conspicuous phenomena of autumn we do not here so much refer to as to those observable during the preparation of herbarium specimens. In autumn, as well known, the leaves fall in consequence of the development of a peculiar layer of cellular tissue at the point of junction of the petiole to the stem of the plant; while the colors come of the leaf being "superoxygenated." But no one has yet uttered so much as a hint as to why some superoxygenate into yellow, others into crimson, others into brown; one here and there, the ash for example declining to superoxygenate at all, and simply dropping to the ground. Leaves and leaflets when drying between papers are often cast off, probably in consequence of derangement in the onward flow of the sap. This happens very markedly in fir-trees, ericas, the wistaria, and various species of cissus and ampelopsis. Peduncles and petals also leave go, as in berberries, flax, the Boussingaultia, and many solanums. The entire inflorescence on that beautiful grass, the *Zizania aquatica*, falls to bits so completely that a skeleton only remains. Crimson flowers very often change to a fine violet purple, as in the case of the erica cinerea, the lagerstrœmia, cyclamens, and the hairy willow herb. The cowslip, on the other hand, changes from yellow to green; and the vanda from white, variously and exquisitely mottled, to irrepressible black. Not unfrequently the entire plant changes to black, and will not be hindered as happens with the aucuba, the lathræa, and the monotropa, in the two last of which, being parasites, we might perhaps expect it, but the aucuba—well, why here? Many plants while drying after death give out an agreeable perfume. New-made hay supplies a familiar illustration. We have other examples in sweet melilot and the woodruff. Sometimes the petals shrivel and contract in a very singular manner quite different from the usual as seen in agrimony and the Bauera; or they go into glassy films as in the eucharis. Anemones, poplars, droseras, hellebores, stain the paper, the dye often not coming out for many months and even years. Mercury is content to assume a beautiful indigo blue color, which, it is said, can be extracted.

These are but a few of the curious changes that could be mentioned. They are given with a view to showing the beginner that he must never be astonished at what may occur. In the case of change of one pleasant color to another, there is nothing really to regret. The only thing to lament over when one's specimens are of colors they need not be, is that we have ourselves been unskillful or neglectful.

* From the *Field Naturalist.*

TAPIOCA.

THE mode of cultivating tapioca in the Straits varies but little on different estates, whether owned by Europeans or Chinese. If jungle composed of large trees is to be cleared, the trees are cut down at some height from the ground, the stumps remaining in the ground, and the whole set on fire, the charred remains of the trees being generally allowed to lie where they fall until the first crop is being cleared off, when they are utilized for fuel. After the ground has been dug over and the soil put into a friable condition the cuttings of tapioca are planted in rows from three to four feet apart and about nine inches or a foot in the rows. The cuttings are lengths about a foot long of the stem of the matured plant. These root easily, and in less than two months the

ground is covered with a carpet of green almost a foot high. From this time to the time the crop is lifted, beyond weeding and slightly banking-up, nothing is done to the crop, although on some estates the tall stems are sometimes cut down to about four feet from the ground, which must evidently keep the plants in a growing state, and prevent the proper storage of starch. On some estates I have known the crop lifted nine months after planting, with good results; but the Chinese planters in Malacca usually keep the roots in the ground sixteen or even eighteen months. Perhaps each has its advantages, but it has struck me that tubers kept in the ground over a year develop a large amount of woody fiber without increasing the quantity of starch, which is evidently a disadvantage to the machinery. The general mode of lifting the crop is to cut off a certain portion of the tops, and pull up the tubers, the broken pieces being dug out afterward. Of course, on land that has previously carried a tapioca crop, manure should be used, which, by some planters, is applied previous to planting, and by others after the young plants have started into growth. In Malacca, however, cow shed refuse is a scarce article, and the cost of carriage would be considerable where estates are distant from the base of supply and roads, in many instances steep and bad.

On one estate in Singapore, under European management, a green crop is grown with the tapioca, consisting principally of *Arachis hypogæa*, various crotalarias, principally *C. striata*, etc., which is dug in with lime, etc., while green, for the next crops, but the plan does not appear to find acceptance with other planters. The root of the tapioca it is hardly necessary to describe here, but I may state that while in Malacca I saw some specimens over two feet long, and weighing between six and seven pounds. The roots being laid in heaps are carted to the manufactory, and the sticks laid in stacks for supplying cuttings for the next crop.

The estate first visited in Malacca was Buki Bruang (literally Bear Hill), and here we found J. M. Lyon & Co.'s patent machinery in full working order.

Of course steam is the motive power, in fact the most primitive styles of preparation seem unable to do without this, as I will show later on. The roots, being first divested of their woody tops, are thrown into a large revolving drum, in which pipes are so arranged that constant jets of water play on them as they are turned over and over, and gradually they reach the further end of the drum perfectly clean, and empty themselves into a rasping machine, whence they emerge in the form of a fine pulp, which is thrown direct from the rasper into another cylinder covered either with stout muslin or brass wire gauze, through the sides of which jets of water are continually passing. By this process the starch is separated from the pulp, the starch passing through the muslin or gauze into a tank beneath, where further supplies of water send it off through gutters to vats prepared for its reception, while the pulp is discharged from the drum into baskets and thrown into heaps either for cattle feeding or manure, for either of which I imagine it is little suited.

After the starch in the vats has been allowed to subside the water is gradually drawn off, fresh water supplied, the whole stirred up and again allowed to subside, and the water again drawn off. The treatment of the starch in this stage depends on the purity of the water used—as, unless the tapioca when prepared is of the purest whiteness, it can hardly be given away. Hence, one of the principal points to be attended to is the supply of clean water in abundance. After the starch has become sufficiently pure it is allowed to dry in the vats, whence it is cut out in cakes and is then ready for the last stages of preparation. If tapioca flour is required it is placed first on racks to dry, then on large, almost flat tin sheets which form the top of a brick flue where an extremely gentle fire is kept up.

If flake tapioca is requisite it is submitted to rather stronger heat in concave pans at first, whence it is removed to the previously mentioned sheets and kept turned over with wooden rakes, etc., until it assumes the flake-like form so familiar to consumers in Europe. The flakes are then sifted, to separate the various sizes, and the prepared tapioca is ready for placing in the bags for shipment.

Next morning at six o'clock we were *en route* to another estate, belonging to Mr. Koh Hoon Boh, at Matchap, about eighteen miles distant. The first ten miles is along the public road, along some parts of which in wet situations are large indigenous plantations of the glam (*Melaleuca leucodendron*), the bark of which is used by Malays for calking their boats. In all directions we saw the natives busy planting the rice fields.

On leaving the public road, however, our troubles began; to drive over the road we did the day before was a delight compared with the one it now fell to our lot to drive over, and it was with no little satisfaction that I gave up the reins at Matchap to the syce, after his informing me when within fifty yards of the house that I had two miles more to drive. Here we found the primitive style at work. The roots are first half-peeled with knives, in which operation a large part of the root is cut off, then thrown into a tank of water, when they are washed by the Chinese treading on them; thence they are lifted in baskets to the rasping machine, which is worked by a traction engine, built in the brickwork, and regulated by hand. The pulp falls from the rasper into baskets, which are carried about twenty yards, and the contents emptied on muslin covers of concave wickerwork baskets, above which a wooden water gutter is placed, the supply of water being regulated by plugs over the baskets. Here the Chinamen separate the starch by arranging a constant fall of water on the muslin, and keeping the mass well stirred with their hands until they think they have extracted all the starch, when they throw the refuse pulp away, and receive a fresh supply from the rasper, the water with which they wash the pulp serving to convey the starch to vats prepared for it. Of course the starch prepared in this manner requires more washing than that prepared by the machinery I have described, and I venture to think that consumers in England would prefer tapioca made by machinery, when it need never be handled, to that which is carried about so much among decaying vegetable matter and mud, as that hand-prepared usually is. Here the starch is baked by fire passing beneath a tile-covered flue on which it is placed. Pearl tapioca is manufactured here as follows: A cloth is attached like a hammock to the beams and kept open by cross sticks. A man at each end alternately jerks the cloth to and fro, the slightly warmed starch under this treatment soon forming small, completely spherical balls, which are afterward baked on a tile-covered flue.

The number of coolies about here was surprising, and it is hardly necessary to say that only about thirty piculs of tapioca is produced per diem; in fact, Mr. Koh Hoon Boh is so thoroughly convinced of the superiority of manufacture combined with economy of the preparation by machinery, after comparing the cost at his estate, which we visited the day before, with the cost of hand preparation, as at Matchap, that he ordered a machine to be erected at once.—*The Gardener's Chronicle.*

PLANTS AND THEIR HOMES.

THE large collection of beautiful and instructive pictures of flowers painted in various countries by Miss Marianne North, is now, through the noble generosity of this lady, the property of the nation. The collection is in a handsome building specially erected in Kew Gardens for the purpose, at Miss North's expense, and from designs given by Mr. James Ferguson, F.R.S. Last week the gallery was opened without any ceremony whatever, and henceforward it will be open and free to the public at the same times and hours as the museums and other buildings in the Gardens.

Now that this is an accomplished fact, a few words respecting the history and the principal features of the collection may be useful. Impelled by a love of nature, Miss North has spent many years traveling from country to country, and painting the most striking scenes and objects that came under her observation; and from time to time some of these paintings have been exhibited in London. The more Miss North traveled and painted, the more the desire to travel and paint seems to have grown; the result being a large collection of pictures. Then arose the question, what should be done with them? and happily in this Miss North was influenced by the kindly feeling that she would like other less fortunate persons to see and enjoy what she herself had seen and enjoyed so much. This idea once conceived, the warm-hearted artist and traveler set to work more assiduously than before, in order to carry it into effect, even visiting Australia and New Zealand, for the purpose of painting the vegetation of that region. In a country where the love of flowers is general, from the poorest to the richest, such a gift as that now offered to the public will assuredly be fully appreciated.

MISS MARIANNE NORTH, DONOR OF THE BOTANIC PICTURE GALLERY, KEW GARDENS.

The collection is designated in the title of the catalogue as paintings of "plants and their homes," and this title is justified by the fact, that in nearly all the pictures, plants have supplied the motive, the other objects represented being accessories. Altogether there are upward of six hundred pictures, representing vegetation in nearly all temperate and tropical parts of the world except Europe and Africa, unless we regard Teneriffe as belonging to the latter country. A descriptive catalogue, compiled by the writer of this notice, and published at Miss North's expense, contains not only the titles of the pictures, but also short notes concerning the life-history, products, etc., of the plants painted, inserted with the intention of making it as instructive as possible to those who know least of such things. There are representations probably of not less than a thousand species, and these include members of nearly every natural order in the vegetable kingdom. The fruit and other useful plants of the different countries are numerous; and associated with them are many of the most ornamental and most striking wild and cultivated plants. In dealing with trees and shrubs, the artist has usually painted a flower-bearing or fruit-bearing branch, or both, in front, and given the habit of the tree or shrub in a landscape behind. Without being botanical, the paintings of the plants are so thoroughly naturalistic, that a botanist has little difficulty in determining such as are not known to him by sight. In so far as regards its prominent features and peculiar types, the Australian flora is more completely portrayed than any other, about seventy-five pictures being devoted to this region. Miss North visited Queensland, New South Wales, Victoria, Tasmania, South Australia, and West Australia; and from each of these colonies she brought home paintings of a large number of the most striking and characteristic plants. Thus of Eucalyptus there are portraits of *E. amygdalina*, *calophylla*, *colossea*, *cordata*, *ficifolia*, *globulus*, *tetraptera*, and several others; of other characteristic Myrtaceæ, the genera Callistemon, Syncarpia, Agonis, Melaleuca, Beaufortia, and Leptospermum; of Leguminosæ, Acacia, Gompholobium, Kennedya, Cianthus, Platylobium, etc.; of Epacrideæ, Leucopogon, Richea, Epacris, Lissanthe, and Styphelia; of Proteaceæ, Banksia, Grevillea, Xylomelum, Telopea, Hakea, Lambertia, Macadamia, Petrophila, etc.; of genera belonging to other natural orders, taking them in the order they occur in the pictures: Phyllocladus, Doryphora, Casuarina, Pimelea, Prostanthera, Billardiera, Exocarpus, Anigozanthus, Xanthorrhœa, Kingia, Cephalotus, Cheiranthera, Xanthosia, Leschenaultia, Stylidium, Johnsonia, Trichinium, Isotoma, Byblis, Actinotus, Nuytsia, Doryanthes, Fusanus, Cosmospermum, etc, etc. In conclusion I may state that there is a complete index to the catalogue, so that it is possible to ascertain what plants are figured by reference thereto.—*W. Botting Hemsley, in Nature.*

COAL IN GERMANY.—It appears that in 1881 Germany imported 1,109,409 tons of coal from England direct, and 339,246 tons from England, *viâ* Hamburg, 309,785 tons from Austria and Hungary, 47,228 tons from France, and 45,991 tons from Belgium. On the other hand, Germany exported 7,458,266 tons of coal in 1881, viz., 2,481,062 tons to Holland, 2,058,027 tons to Austria and Hungary, 981,529 tons to France, 562,646 tons to Belgium, 455,635 tons to Switzerland, 373,274 tons to Russia, 279,126 tons to Bremen, and 247,025 tons to Hamburg.

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